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Report No. DSA-66

AN EMISSIONS CONTROL DECISION AID

VOLUME I

July 1978

prepared under contract N00014-77-C-0322
interim report for period 28 March 1977 - 30 April 1978

Approved for public release; distribution unlimited.

prepared for:

OFFICE OF NAVAL RESEARCH
Department of the Navy
800 North Quincy Street
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P. G. /Tomlinson

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ABSTRACT

The EWAR decision aid assists a Task Force Commander in designing and evaluating an EMCON plan. It provides displays for data retrieval, for the analysis of surveillance effectiveness, for the evaluation of information given away, and for the trade-off of surveillance effectiveness with information given away. The report discusses the rational for the EWAR decision aid and explains the context in which the aid is likely to be most useful. Another section describes how the aid might be used to evaluate an EMCON plan and provides examples of many displays currently operational. The report includes three annexes. The first, included in Volume I, describes all available commands. The other two annexes, included in Volume II, outline the program subroutines. The report describes the aid as it was implemented in April 1978. Although no significant changes in fundamental software design are anticipated, the final version of the aid is expected to contain several user-oriented features somewhat different from those discussed here.

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CONTENTS

CONTENTS (CONT'D.)

LIST OF FIGURES

LIST OF FIGURES (CONT'D.)

LIST OF TABLES

1.0 INTRODUCTION

This report describes a prototype emissions control decision aid developed by Decision-Science Applications, Inc., (DSA) for the Office of Naval Research (ONR) under contract N00014-77-C-0322. The aid was developed as a part of ONR's Operational Decision Aids (ODA) program. The decision aids developed in the program are intended to serve a dual function. First, they illustrate decision aiding concepts and principles that could be applied within the operational Navy to assist the Task Force Commander and his staff. Second, they provide a test bed that can be used to gain a better practical understanding of man/machine interactions in the use of such aids.

This dual application requires certain obvious compromises in system design. On the one hand, such a system must reflect the essential features of operational decision and planning problems so that the concepts developed will be as relevant as possible (and potentially transferable) to an operational environment. On the other hand, the actual prototype aid must be kept unclassified, so that the initial experimentation and testing of the aid can be carried out in the ONR unclassified environment. The present aid has been designed to meet this dual requirement. For this reason, the discussion of the EMCON planning problem in this report will be at the unclassified level. Readers who are familiar with the classified literature concerning EMCON planning will therefore find certain areas where the discussion is over simplified, as well as areas where certain classified electronic warfare considerations have been omitted from the discussion.

The EMCON planning aid is designed to assist the Task Force E.W. (electronic warfare) Officer in developing emission control plans as a part of the Op Order (Operations Order) for the Task Force. The basic

purpose of an EMCON plan is to limit the information that might be given away to an opponent as a result of electronic, acoustic, and other emissions, from the Task Force. An EMCON plan can be designed to deliberately deceive the opponent, or it can be designed simply to limit nonessential emissions and thus avoid giving unnecessary information to the opponent. In developing such a plan, the E.W. Officer must weigh the importance of having specific radars, sonars, and communications systems, in operation against the value of information that can be conveyed to the opponent if the equipment is turned on.

Typically, the electronic warfare Op Order for a Task Force will specify several alternative EMCON plans which can be selected by the commander for different phases of the Task Force Mission. For example: EMCON Plan Alpha may specify total silence of all radiating equipment; Plan Bravo may allow all equipment to be turned on; Plans Charlie, Delta, etc., may specify a number of intermediate options in which only certain specific emitters are allowed to operate.

Obviously, the extreme EMCON plans that have all equipment either on or off are no problem to develop. The decision aid therefore is primarily to assist the E.W. Officer in developing effective and efficient EMCON plans for the intermediate cases. Typically, such a plan is specified in the form of a matrix, where the rows correspond to the ships in the Task Force and the columns correspond to the types of radars, sonars, fire control equipment, etc., that are present in the Task Force. To specify the plan, the E.W. Officer must specify the status for each emitter in the Task Force: off or on; or the specific circumstances under which it is permitted to radiate. The development of such plans at present is a time-consuming task, and there is very little guidance for what criteria should be used to develop the plans.

One of the most serious operational problems concerns the interaction of the EMCON plan with the effectiveness of the air surveillance and air defense capability of the Task Force. Almost regardless of his

specific mission, the Task Force Commander must be concerned with the possibility that the Task Force might be subject to a surprise air attack by enemy aircraft or cruise missiles. To maintain adequate air surveillance against such a surprise attack some of the air surveillance radars in the Task Force must be allowed to operate. But, if too many radars are turned on, the enemy will be able to use the radar emissions themselves to locate, track, and identify, the ships in the Task Force. The usual goal in the design of the EMCON plan therefore is to maintain reasonable security concerning the disposition of the Task Force, while at the same time maintaining adequate air surveillance to avoid undue vulnerability to a surprise attack. The decision aid is designed to assist the E.W. Officer in developing plans that can provide the most favorable balance between these potentially conflicting objectives.

This report consists of two volumes. Volume I includes the main paper along with Annex A, "User Commands." The main paper provides a general introduction to the decision aid. To provide the necessary background for nontechnical readers, it begins with a general discussion of the emissions control (EMCON) planning problem. This is followed by a functional description of the decision aid, showing how the aid is designed to assist the EMCON planner. Finally, the operation of the aid is illustrated by working through an illustrative planning problem. Annex A, "User's Command," provides specific instructions concerning the use of the system that a user would need to work with it interactively. Volume II includes Annexes B and C. Annex B, "Program Description," provides the detailed program documentation that would be needed by a programmer in order to modify the existing programs. Annex C, "Graphics Software Subroutines," provides information on the graphics software.

2.0 THE EMCON PLANNING PROBLEM

Task Force decisions concerning emissions control can be divided into three phases. First, before the Task Force mission begins, there is a planning phase in which the electronic warfare annex is developed for the Task Force Op Order. It is at this stage that the E.W. Officer decides on preplanned alternative EMCON plans that are to be available for use by the Task Force, and he works out a detailed matrix which specifies the status of each emitter for each plan. Second, during the early phases of the mission, the E.W. Officer may find that it is necessary to make small changes or refinements in the original plans, either because of reliability problems with specific pieces of equipment or because of new information concerning the disposition or activity of enemy forces. Finally, during the implementation of the mission, tactical decisions must be made concerning when the Task Force is to switch from one EMCON plan to another. Such operational changes in the EMCON plan may be simply an implementation of a preplanned strategy as the mission develops or changes can occur without preplanning in response to unexpected enemy activity. For example, if it suddenly becomes clear that the Task Force is actually under air attack, the Commander will almost certainly switch to an EMCON state in which all or almost all air surveillance radars are operational.

The present EMCON planning aid is designed primarily to assist the E.W. Officer in the first two phases, i.e., developing the initial EMCON plans and refining or adapting the plans during the early phases of the mission. The aid is not designed to assist in making the tactical decisions about when to switch from one state to another, although it seems likely that experience working with the aid should improve the officer's judgment concerning such decisions.

Table 2.1 lists the basic steps that the E.W. Officer must go through in the development of the plan. At present the development of an EMCON plan is a tedious process, and the majority of the effort is usually expended in collecting and organizing the relevant information. The first

TABLE 2.1

STEPS IN DEVELOPMENT OF
EMCON PLAN

1. Identify relevant ships and aircraft
   - Own forces
   - Enemy forces
   - Neutral
2. For each platform, identify relevant electronic equipment
   - Emitters (radar, sonar, como)
   - Sensors (ESM, passive sonar, radio)
   - Jammers
3. Obtain electronic characteristics of each equipment
4. Match equipment by frequency range
5. For each EMCON option assess pros and cons of radiation for each piece of equipment
6. Decide status

three steps in Table 2.1 are concerned with this collection and organization of the relevant information. One of the major problems is to ensure that the specified electronic equipment for each ship and the characteristics of the equipment is up to date. The organization of the information by frequency range in Step 4 brings together all emitters that are likely to interfere with each other and makes it easy to relate them to possible listening equipment and jammers in the same frequency range. Finally, in Steps 5 and 6 the planner assesses the advantages and disadvantages of each piece of equipment and decides whether it should be turned on or off. In practice, of course, the decision for each piece of equipment cannot be made in isolation since there are important interactions. Often the decision will be to turn off all equipment of a particular type, or to leave it all on. In other cases it may be sufficient to have a small number of a particular piece of equipment in operation. The oversimplified form of this official guidance is indicative of the lack of formal or established procedure for making EMCON decisions.

Because of the large quantity of data involved and the complexity of the planning problem, the Task Force E.W. Officer usually has little time to address the real decision issues in EMCON planning. Therefore, he usually does not attempt to develop a plan that is tailored to his specific tactical situation. Instead, he begins with a fairly standard set of plans that have been developed over a period of time at fleet headquarters. Usually the E.W. Officer will make only the minor modifications in these plans that seem to be required by special characteristics of his Task Force or its assigned mission.

The final effectiveness of an EMCON plan depends not only on the quality of the plan but on the reliability with which the plan can be implemented. The Navy is presently experiencing a number of practical problems in the implementation of the plans. For example, as a result of human error, specific pieces of equipment may not be turned off even though the plan has specified that they must be off. Such oversights can

negate much of the value of a carefully designed plan. In other cases it has been found that leakage of radiation from equipment that is maintained in a dummy load standby state can be large enough to be easily detected by enemy listening equipment.

As a consequence of these operational problems, there are currently wide differences in opinion about what types of changes in the EMCON plans would be most useful. The officers who are mainly concerned with operational implementation of the plans tend to feel that one of the most useful steps would be to standardize on a relatively limited number of EMCON plans so that operational personnel could become familiar with the plans and thus implement them more reliably. The E.W. Officers who are responsible for the development of the plans and the analysis of EMCON alternatives tend to feel that their inability to effectively tailor an EMCON plan to a specific tactical situation is one of the most serious current problems. These officers also are concerned that any effort to use standardized plans would destroy much of the value of EMCON planning as a deceptive strategy.

A number of steps are now being undertaken which should help to correct some of these present practical problems which interfere with effective EMCON operations. For example, a system is to be installed which will give the commander of each ship positive control over the emissions of every emitter. This should make it much easier to successfully implement EMCON plans. At the same time, steps are being taken to provide computer readable files with up-to-date electronic order of battle information which can be used by the Task Force E.W. Officer in developing and modifying his EMCON plans. The availability of such information in a conveniently accessible form should greatly reduce the drudgery of EMCON planning and give the E.W. Officer more time to consider the real decision issues.

As some of the present practical problems are corrected it seems likely that the E.W. Officers will be able to give more attention to the quality of the EMCON plans. The prototype decision aid is oriented toward this type of future environment, and within that environment it is designed to assist the E.W. Officer in addressing some of the key tactical trade-offs in EMCON planning.

3.0 OVERVIEW OF DECISION AID

At present the real tactical trade-offs in EMCON planning are rarely addressed. Air defense officers typically feel that their job is to provide the best possible air surveillance and air defense subject to constraints that are specified in the EMCON plan. The E.W. Officers tend to view their responsibility as the development of the best possible EMCON plans to maintain Task Force security, subject to constraints that are defined by air defense and other operational activities of the Task Force. In fact, of course, there are important trade-offs between air defense effectiveness and the EMCON plan. The decision aid is designed to make these trade-offs more apparent and thus to encourage E.W. Officers to explicitly consider the trade-offs in their planning process.

The EMCON decision aid is designed to utilize a computerized data base such as might be available at the Fleet Headquarters or in the Task Force Command Center for a Modernized Navy at Sea. The present prototype system uses an unclassified demonstration data base which was developed under the ONR Decision Aiding Program for the DEC-10 computer at the University of Pennsylvania. The prototype decision aid retrieves, displays, and analyzes, information contained in the unclassified data base, just as an operational version would interact with a classified operational base.

Because of the large amount of data involved in the EMCON planning process, the planner's most critical need is for simple assistance in the retrieval, display, and organization, of the relevant information. Until these basic needs are met, the planner is unlikely to be able to use any of the more sophisticated decision aiding capabilities. For this reason the EMCON decision aid provides a family of interrelated planning aids. At the lowest level it provides routine assistance in the retrieval and display of relevant information from the data base. At a slightly higher level it provides the user with certain types of computational assistance which can eliminate hand calculations that would otherwise be required.

Finally the system includes a number of detailed outcome estimation calculations which are too extensive to be carried out by hand, and it provides decision aiding support to assist the planner in analyzing and interpreting these calculations. Table 3.1 lists some of the specific functional capabilities of the system.

TABLE 3.1

FUNCTIONAL CAPABILITIES OF SYSTEM

1. Data retrieval support
2. Frequency management display
3. Surveillance coverage displays
4. Assessment of information given away
   - Ship identity information in emissions
5. Surveillance effectiveness assessment
   - Air attack outcome evaluator
6. Trade-off analysis

This table will be used to discuss the way a planner might use the system in the development of an EMCON plan.

3.1 DATA RETRIEVAL SUPPORT

As previously illustrated in Table 2.1, the first three steps in the development of an EMCON plan are concerned with fundamental data collection and data organization processing. The data retrieval support capability of the system is designed to assist the user in carrying out these initial steps in the EMCON planning process. The central data base includes basic information of the types required to carry out these steps.

The data base includes information on friendly forces, enemy forces, and neutral forces. The planner begins by identifying the specific ships and aircraft types that he considers to be relevant to his planning process. These include the specific ships in his own task force, as well as potential and hostile forces that he expects to be within his area of operation. This defines the environment within which the EMCON plan is to be developed.

The data base also includes electronic order of battle and information for each ship. Thus, the user also has access to information concerning the specific emitters, sensors, and jammers, that are available on each platform. In addition, the data base includes information on the relevant electronic characteristics of each piece of equipment. Consequently, once he has identified the relevant ships and aircraft for his analyses, the other types of information that he will need for his analyses become automatically available so that he can obtain the information through simple interrogation commands. However, because of the quantity of information involved, the planner will need assistance in organizing this information in a convenient form to carry out his analyses.

3.2 FREQUENCY MANAGEMENT DISPLAY

The frequency management display provides one of the most useful tools to assist the planner in the organization of his information. The purpose of the display is to assist the planner in focusing his attention on any specific frequency range that is of interest to him. To use the display he specifies the specific frequency range that he wishes to study and he obtains a display showing the specific emitters, jammers, and sensory equipment, that are operating in that frequency range. The information is displayed in the form of a frequency spectrum with color-coded bars showing the portions of the frequency range that are covered by specific pieces of equipment.

To develop his E.W. plan, the user can specify which particular pieces of equipment are to be turned off or on. To assist him in analyzing possible interference problems, the display has the capability to show harmonic radiations, as well as primary radiation frequency, for each emitter. As the planner develops his E.W. plan, he can move his attention from one frequency range to another to see the results of his decisions at different frequency ranges.

3.3 SURVEILLANCE COVERAGE DISPLAYS

The planner's decisions concerning emission control can affect the operation of communication systems, power control systems, active sonar surveillance systems, as well as air surveillance systems. For the prototype decision aid it was decided to concentrate on the implications for air surveillance performance. Some of the rationale for this decision is as follows.

The degradation of Task Force performance that can be expected as a consequence of EMCON limitations on communications systems is so dependent on the specific mission and operating philosophy of a Task Force, that it seems difficult to devise an aid in this area that could improve significantly on unaided human judgment.

In the case of fire control systems (assuming that appropriate provisions have been made for standby and dummy-load operation) the effectiveness of these systems should not be appreciably degraded by normal EMCON constraints. At least in principle, fire control equipment does not need to be in operation until after a hostile air threat has been detected by the surveillance system. When it becomes apparent that the Task Force is actually under attack by such a hostile threat, it will almost always be appropriate to allow the fire control system to be turned on.

For these reasons the effects of EMCON limitations on air defense capabilities tend to be most significant in connection with the air surveillance systems (which by their nature need to be in operation before any specific enemy air attack has been detected). The decision aid therefore includes a number of capabilities that are intended to assist the user in evaluating the impact of EMCON limitations on air surveillance effectiveness.

The simplest air surveillance aids consist of simple displays of the air surveillance radar coverage over the task force. To make use of these surveillance coverage aids, the user specifies the planned geographic disposition of the task force. Specifically, he specifies the position of each ship vis-à-vis some arbitrary reference point, which for convenience might be chosen as the location of the Task Force command ship. Once this geographic distribution of the ships has been specified the air surveillance coverage can be shown in a number of different ways.

The present decision aid includes three separate representations. The first representation shows a surveillance coverage circle corresponding to the range for 90% detection probability on a target of one square meter radar cross section. A second representation uses different densities of shading to illustrate the level of redundancy in the radar coverage. Finally, there is a representation which shows detection rate probability contours over the entire fleet.

Recent discussion with Naval air defense officers has suggested a different type of representation which explicitly represents cumulative detection probability contours for incoming aircraft from any specified direction. Our current plans are to add an additional surveillance coverage display of this type before beginning the testing and evaluation process for the decision aid.

The purpose of all these surveillance coverage displays is to provide the planner with an intuitively meaningful representation of the air surveillance coverage over the fleet. The planner should be able to use these displays to identify specific weaknesses in the air surveillance coverage and to correct these weaknesses either by changing the deployment of the ships or by making changes in the air surveillance radars that are kept in operation.

The prototype decision aid includes a larger number of alternative representations than would be appropriate in a final operational system. It is anticipated that the test and evaluation phase will provide information concerning which types of representation are most useful to the air defense planner. A final operational system would therefore include only the displays that have been demonstrated to be most useful.

3.4 ASSESSMENT OF INFORMATION GIVEN AWAY

The other side of the EMCON planning problem concerns the information that is given away to the opponent as a consequence of emissions from radar, sonar, communications equipment, etc. The EMCON planner will be concerned with a wide variety of information that can be given away by these radiations, such as:

1. The mere presence of the task force.
2. The position of ships in the task force.
3. The identity of ships within the task force.
4. The current activities and future intent of the task force.

Although all of these types of information are important (and at specific times within a mission, each of these may be the main concern of the planner), it was felt that a computerized aid could be most valuable in connection with the problem of ship identity. Some of the rationale for this conclusion is as follows.

Presence can be given away by any emitter that is turned on in an area and frequency range that is within enemy monitoring capabilities. In this sense, the problem of presence is almost trivial, and the planner is not likely to need computerized assistance to know when his emissions can give away "presence" information. On the other hand, the knowledge that ships are present in an area may not be of much use to the opponent unless he has reason to identify the ships as part of a task force. When the problem of presence is restated in this form it really becomes a problem in the identity of the ships that are known to be present. To the extent that the planner needs assistance in this type of identity problem it can be provided by a system that is designed to deal with the general problem of ship identity.

Information that can be given away concerning ship position is also quite simple and does not seem to require a computational aid. If the opponent has appropriate direction-finding equipment he can triangulate on any emitted radiation. To avoid such direction finding, radiation silence is impractical for an operating Task Force, and the planner has to settle for a more limited form of security in which he recognizes that both physical presence and position are probably compromised. The planner must avoid revealing the identity of the Task Force as a whole, but where that is not feasible, he will still want to protect the identity of individual ships within the Task Force. The present decision aid is intended to assist the planner in evaluating the information that is given away concerning either of these identity issues.

The final type of information that can be given away concerns the specific activity and intent of the Task Force. To some extent the opponent will, of course, be able to deduce current activities if he can monitor the position and identity of ships in the Task Force. Therefore, EMCON procedures that limit his knowledge of ship identity can make it

more difficult to guess either the current or probable future activities of the Task Force. The opponent's best potential source of information on Task Force activities and intent, however, is contained in the communication channels where messages transmitted (either in the clear or with inadequate encryption) can give away vital information on the plans and activities of the Task Force. Although security of communications is a vital part of electronic warfare, it is not treated by the present decision aid and, moreover, this does not now appear to be an area where computerized assistance would be very helpful to the planner.

For the reasons just mentioned, the analysis of information given away within the present decision aid is focused on the problems of Task Force identity and the identity of ships within the Task Force. The planner can use the aid to obtain an estimate of the degree to which the Task Force ships would be uniquely identified relative to other commercial and military traffic in the area. He can also use it to obtain an estimate of the degree to which the opponent might be able to correctly identify individual ships within the Task Force.

To use this identity analysis part of the decision aid, the planner would experiment with various changes in his EMCON plan and for each change he would obtain an assessment of the resulting information available to the opponent. To make his overall decision, the planner can weigh the beneficial effects on the information given away of turning a radar off against the reduction in air surveillance as shown by the air surveillance coverage displays. By comparing these two conflicting aspects of the problem, he may be able to converge on a good compromise decision which would be reasonably effective in both areas.

However, in order to do so, the planner would have to make some rather difficult intuitive judgments. For example, he would have to estimate the extent of which changes in air surveillance coverage would affect overall air defense effectiveness. Similarly, he would have to

weigh the importance of such changes in air defense effectiveness against the tactical importance of the information given away to the opponent. Although some planners may feel able to do this, others may find that such judgments are difficult to make. For this reason, the decision aid is provided with two additional capabilities to assist in evaluating and balancing the conflicting objectives.

3.5 SURVEILLANCE EFFECTIVENESS ASSESSMENT

Although information on air surveillance coverage can be very useful to an experienced air defense officer, it does not really provide a quantitative measure of performance. The real purpose of the surveillance system is to provide information on enemy air threats in sufficient time to allow the fleet air defense system to respond efficiently. Consequently, to correctly assess the performance of the air surveillance system, the planner needs to know how changes in air surveillance coverage will affect the overall air defense effectiveness.

The decision aid therefore includes a simplified air defense model designed to help the planner assess the effects of changes in air surveillance coverage on the overall air defense capability. To use this portion of the aid, the planner specifies the types of air threats (numbers, altitude, radar cross section, and ordinance) that he wishes to consider. The aid provides an assessment of the outcome of such attacks as a function of the air surveillance coverage. The outcome assessment includes an estimate of the number of hits in each ship and the total expected damage for each air surveillance alternative he wishes to consider.

Obviously, the actual outcome of an enemy air attack would be dependent on numerous details concerning the attack and the configuration of the Task Force air defense. But an attempt to include all of these considerations within the decision aid would result in much too complex and cumbersome a system for the planner to use. Since the purpose of the system is not really to predict air defense outcomes, but

rather to provide an estimate of the dependence of air defense effectiveness on air surveillance, it is not necessary to include such detail. To make the aid as easy as possible to use, the representation of the enemy attack and Task Force air defense within the model has been kept as simple as possible, consistent with the objectives of the aid. In particular, the performance of the Task Force air defense (after the threat is detected by the air surveillance system) is specified in terms of a small number of user-supplied planning factors. This makes possible an extremely simple calculation of air defense performance which can be easily adjusted to match the planner's assessment of the Task Force air defense capabilities. Once these planning factors have been adjusted by the planner, they are, of course, kept fixed for all of the surveillance comparison cases to provide an estimate of the effect of changes in surveillance coverage on air defense performance.

The calculation of the outcome of an air strike obviously requires some assumptions about the opponent's targeting objectives. In most cases, of course, the EMCON planner will not want to bother with any detailed specification of the enemy's flight plan. For this reason, the aid includes a very simplified air strike planner. This strike planner provides an automatic allocation of the threat vehicles among the ships of the Task Force, and (within user specified azimuth limits for the threat) it selects the most favorable azimuth for attacking each ship. The user can select any one of three different techniques for specifying the attack. He can manually specify the allocation of the attack among the ships in the Task Force; he can request an automatic plan in which the attack is allocated in proportion to the value of each ship; or he can request an automatic plan in which the allocation is optimized to provide maximum expected damage to the Task Force. Using any of these ways of specifying the attack, the planner can consider a variety of air surveillance alternatives and see how these affect the probable level of damage to the Task Force.

3.6 TRADE-OFF ANALYSIS

The selection of an EMCON plan depends on the Task Force Commander's judgment about the importance of reducing the information conveyed to an enemy vis-à-vis the importance of increasing air surveillance. This judgment depends on the Task Force mission, on possible threats to the Task Force, and on many other considerations. Hence, no decision aid can fully replace the Task Force Commander's judgment in preparing an EMCON plan. The EWAR decision aid can, however, assist the Task Force Commander in preparing the plan.

As previously described, the EWAR decision aid provides support to the Commander by providing separate assessments of the capability of a plan to provide adequate air support to the Task Force and to deny information to the enemy. In addition, the aid provides capabilities for making the explicit trade-off between the benefits realized when air surveillance is increased and the corresponding benefits that are lost by the increased information that is given the enemy. These capabilities are provided by means of a "combined scores" plot and a "strike outcome" calculator.

The combined scores plot is a summary plot which weighs, according to the user's discretion, the relative importance of the surveillance and information scores for a set of EMCON plans under consideration. It shows in a single display which EMCON plans are preferred when surveillance is the most important, which are preferred when information denied is the most important, and which are preferred when both factors are preferred equally.

The strike outcome calculator simulates an enemy air strike against the Task Force when a given EMCON plan is in effect. It thus dynamically trades off the advantages that accrue to the enemy through his ability to more accurately target his attackers when surveillance is increased against the advantages that accrue to the Task Force through its ability to detect and intercept the attackers at an earlier time.

The following section describes in greater detail many of the displays available in the aid and illustrates their use in the preparation of an EMCON plan.

4.0 AN ILLUSTRATIVE PLANNING PROBLEM

This section illustrates how an Electronic Warfare (E.W.) Officer might use the EWAR decision aid to evaluate two candidate EMCON plans. It includes many of the displays available in the aid and lists the kinds of data available in the EWAR data base. The example does not include an illustration of all command types. These are too numerous to include in an example whose purpose is to demonstrate the use of the aid rather than to document its features. All commands are described, however, in Annex A of this report.

The example described in this section was devised solely to illustrate the capabilities of the aid. Although many of its features are representative of situations that would be encountered in the real world, no attempt was made to make it fully realistic. More realistic examples are planned for use in the test and evaluation of the aid.

In the example, the Task Force Commander advises his E.W. officer and C.I.C. (Combat Information Center) Officer that he is concerned about a particular enemy threat, that he is concerned that the identity of the Task Force carrier may be compromised and that he would like the E.W. and C.I.C. officers to evaluate two different EMCON plans with respect to the threat. Furthermore, he directs them to evaluate the selected plan when an attacker guesses (but does not know) the position of the carrier even when no radars in the Task Force are emitting.

The C.I.C. officer delegates these tasks to the E.W. Officer who evaluates the threat using the EWAR decision aid. The Task Force Commander does not interact with the aid directly. From his perspective the effect of the aid is similar to having more efficient E.W. and C.I.C. officers. The Commander can ask them to examine more EMCON plans, to consider a larger number of threat possibilities, and to report to him the specific advantages and disadvantages of these EMCON plans in detail. He also expects them to modify the candidate plans to accommodate equipment failures, and to develop new plans which are more appropriate for the specific threats anticipated than any of the previously designed "canned" plans.

The E.W. Officer follows the same general procedure for evaluating an EMCON plan with the aid as he does manually. Table 4.1, which lists the six steps he follows, is reprinted here for convenience.

The E.W. Officer's first step is to identify relevant ships and aircraft, both friendly and hostile. He enters the Task Force into the EWAR data base using the INSERT and POSITION commands documented in Annex A, and confirms this data by listing his Task Force ships (Fig. 4.1) and plotting their position (Fig. 4.2). He may also retrieve from the data base detailed information about particular ships or surveillance aircraft. Figures 4.3a and 4.3b display the detailed data base information concerning the aircraft carrier Kitty Hawk and surveillance aircraft Hawkeye.

The E.W. Officer next enters the expected enemy threat into the EWAR data base. Enemy threats are defined using the THREAT and STRIKE commands. The THREAT command defines the characteristics of a single enemy attacker. Figure 4.4 lists the attributes which define a threat. These include a threat name, its velocity, altitude, radar cross section, and ordnance data.

The STRIKE command defines a plan for an air attack. This plan consists of a number of threats attacking the Task Force using bearings and laydowns calculated according to a prescription specified in the STRIKE command. Note that the E.W. Officer is not simulating an air strike at this stage of his EMCON plan development. The actual simulation occurs later in the procedure during the evaluation of specific EMCON plans. At this stage he is still specifying the scenario.

This distinction between specifying a STRIKE plan and simulating the outcome of this strike against a specific EMCON plan is reflected by the kinds of information supplied by the STRIKE command. For example, the laydown of attackers to ships is generally a prescription for a laydown and not a rigid ship-attacker assignment which does not vary with changes in EMCON plans.

TABLE 4.1

STEPS IN DEVELOPMENT OF
EMCON PLAN

1. Identify relevant ships and aircraft
   - Own forces
   - Enemy forces
   - Neutral
2. For each platform, identify relevant electronic equipment
   - Emitters (radar, sonar, como)
   - Sensors (ESM, passive sonar, radio)
   - Jammers
3. Obtain electronic characteristics of each equipment
4. Match equipment by frequency range
5. For each EMCON option assess pros and cons of radiation for each piece of equipment
6. Decide status

```
LIST,SHIPS

KITTY HAWK                                      SPRUANCE
NASTY                                           TRUETT
CHICAGO                                         OKLAHOMA CITY
VIREO                                           WIDGEON
BOWEN                                           HOLT HE
```

Figure 4.1. The Active Task Force Ships

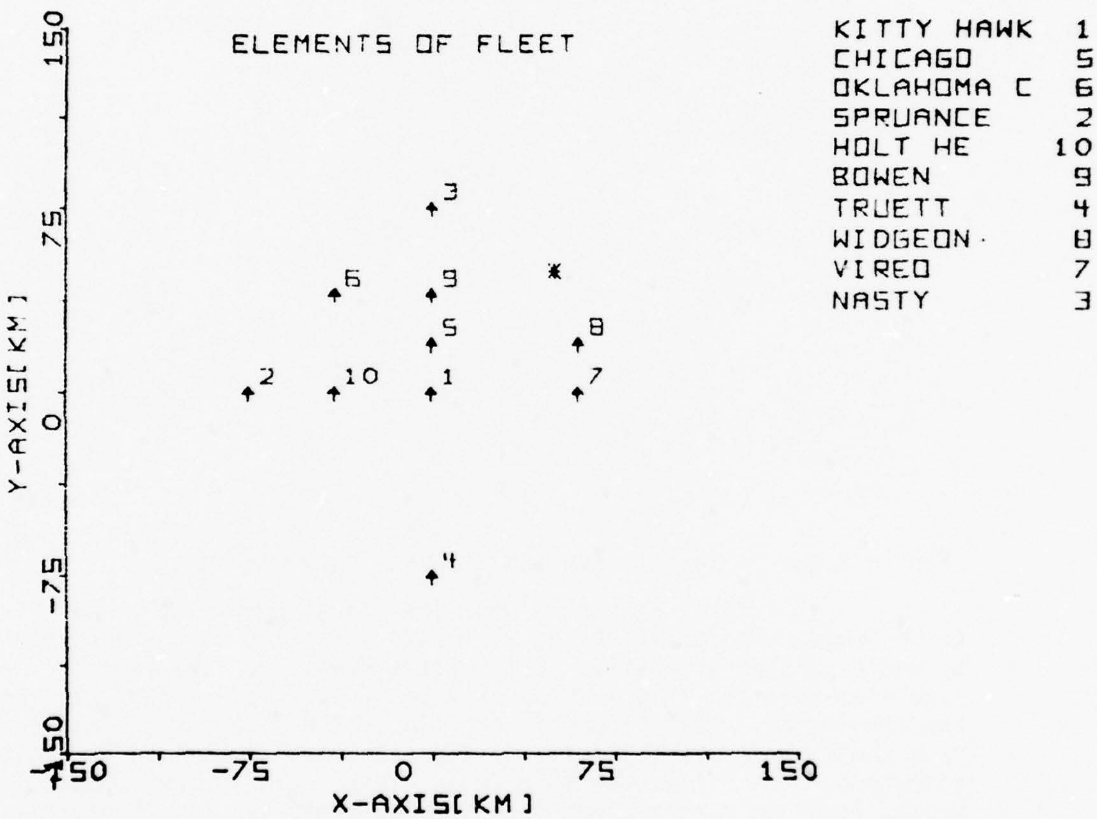

Figure 4.2. The Task Force Configuation

The position of each ship is plotted relative to the Kitty Hawk, ship number one. The asterisk (*) is a surveillance aircraft.

```
LIST,DETAILS,SHIP=KITTY HAWK

SHIP:                       KITTY HAWK
POSITION (X,Y), (KM   ):      0.0000        0.0000
SHIP VALUE:                 939.5000
SHIP IS IN THE FLEET
HARDNESS:                    30.6513
LENGTH (M    ):             323.9000
TYPE:                       CARRIER
CLASS:                      KITTY HAWK
BLIP VALUE:                 426.1000
FLAG:                       BL
INDEX ID=                          1
```

Figure 4.3a. Ship Data Available in the EWAR Data Base

Kitty Hawk ship position is assigned by the user to be (0,0). The positions of all other ships are then described by their positions relative to the Kitty Hawk. "In the fleet" signifies that the ship is presently being utilized as part of the simulation. Were it not in the fleet, the data for the Kitty Hawk would be ignored, just as if the ship were in port of located elsewhere. The Kitty Hawk ship value listed here is the default value, equal to a normalized ship displacement. PT boat Nasty has the default value of one. The hardness shown here is also a default value, set to the square root of the value of the ship. The hardness default varies with value because more valuable ships typically require more hits to kill. Blip value is the value assigned to the Kitty Hawk radar blip by the enemy. It is the weighted average of ship values which could correspond to that blip. Flag is BL, for side blue. Index is the number used to identify Kitty Hawk on the map displays.

```
LIST,DET,AC=HAWKEYE A

AIRCRAFT ID:            HAWKEYE A

AIRCRAFT TYPE:          E-2
POSITION:                      1.ØØØØ KM       5.ØØØØ KM        4ØØØ M
AIRCRAFT IS ON STATION.
```

Figure 4.3b. Aircraft Data Available in the EWAR Data Base

Aircraft ID is the aircraft's unique identifier. Aircraft type is the military type designation. The X- and Y-coordinates of the aircraft are measured from (0,0)--the position of the Kitty Hawk. The Z-coordinate is measured in meters above sea level. "On station" signifies that the aircraft data is presently being utilized as part of the simulation. Were it "off station," the data would be ignored, just as if the aircraft were not on station.

```
LIST,DETAILS,THREAT=BOMBER
THREAT ID                                  =BOMBER
ALTITUDE                                   =    6.Ø994
RADAR CROSS SECTION (SQM)                  =     6Ø.ØØ
VELOCITY (KM PER SEC)                      =  285.ØØ14
NUMBERS OF WEAPONS CARRIED                 =   2Ø
WEAPON YIELD                                      Ø.1Ø
WEAPON CEP (HOR,VERT  (M))                 =      3Ø.5
EFFECTIVE LAUNCH RADIUS (KM)               =    Ø.Ø3Ø5
RECORD UPDATE TIME (SEC)                   =  191.Ø45Ø
```

Figure 4.4. Characteristics of the Threat "Bomber"

The meaning of most data items is self-explanatory. Weapon yield units are related to weapon P_k (probability of kill given a hit) so that a yield of one against a ship having a hardness of one has a P_k of 0.5. In the future, yields will be metric tons TNT equivalent, and hardness units will be appropriately changed. The effective launch radius is the distance from the target at which the weapon may be launched. An attacker within this launch radius is assumed to have launched its weapons.

In this example the E.W. Officer defines two different strike plans, each using a different laydown rule. The first strike specifies an "optimized" attack in which the attacker knows the identity of every ship. He labels this strike SHIPINF and stores it for future use. The second strike plan assumes that the attacker does not know the identity of each blip on his radar screen, but must infer ship identity from task force emissions, from his knowledge of the task force electronic order of battle, and possibly from other intelligence. He saves this strike plan under the name BLIPINF. In the future, whenever he wishes to evaluate an EMCON plan with reference to these strikes, he need only call these strikes by name. To emphasize again, these strikes are not stored as fixed laydowns, but rather are prescriptions for finding a laydown. That is, if the task force configuration or the set of emitting radars were to change, the assignment of attackers to ships produced by these strikes may change. Nevertheless, regardless of EMCON plan or task force configuration both strikes are optimal; and, therefore, both strikes take advantages of whatever weaknesses exist in the task force disposition. If the E.W. Officer preferred invariant strikes, he could specify a strike using a "manual" allocation, but in this example he does not choose to do so.

The two strikes BLIPINF and SHIPINF have different functions in the EMCON plan analysis. The strike SHIPINF does not depend on the attacker's ability to infer ship identity. It is intended as a tool for judging surveillance effectiveness. The strike BLIPINF depends both on surveillance effectiveness and on ship identity inferences. It is intended as a tool for balancing the information and surveillance aspects of the E.W. problem. The difference between the outcomes when these two strikes, BLPINF and SHPINF are simulated therefore reflects the value of information withheld from an attacker. The strike characteristics may be reviewed using the LIST, DETAILS, and STRIKE, commands. A summary of strike SHIPINF is displayed and explained in Fig. 4.5.

```
  LIST,DETAILS,STRIKE=SHIPINF,THREATS=ALL
THREAT NAME          TOTAL NUMBER    NUMBER REMAINING
FIGHTER                        1Ø                   Ø
BOMBER                          1                   Ø
  LIST,DETAILS,STRIKE=SHIPINF,PLAN

STRIKE NAME = SHIPINF
 LAYDOWN MODE:  OPTIMAL FOR SHIPS.
 BEARING SELECTION MODE:  OPTIMAL.
                   LOW BEARING=           Ø.Ø
                   HIGH BEARING         36Ø.Ø
                   NUMBER=     4
```

Figure 4.5. A Partial Listing of Strike Plan SHIPINF

Strike SHIPINF consists of an attack by ten fighter-bombers with characteristics specified by threat "fighter," and one bomber with characteristics specified by threat "bomber." The details of the threat bomber, its altitudes, velocities, cross sections, and weapon characteristics, are shown in the figure. The laydown mode, "optimal for ships," directs the strike planner to construct a laydown which maximizes the damage to the Task Force. It assumes that the attacker knows the identity of each ship. The specific laydown of attackers to ships depends on the ship deployment and EMCON plan. It may be listed using the LIST, OUTCOME command as shown in Fig. 4.13. The attacker may attack each ship from a bearing of 0, 90°, 180°, and 270°, for each aircraft. The strike planner selects the most effective bearing for attacking each ship. Annex A includes a more complete description of the strike planning capabilities.

As the next step in the development of an EMCON plan, the E.W. Officer identifies the relevant electronic equipment for each platform. He uses the command LIST, RADAR, SHIP = ALL, to display the status of the radars on each Task Force ship. He then compares the EMCON plan currently stored in the aid to the plan which is to be evaluated and uses the ON and OFF commands to modify the current plan appropriately. Figure 4.6 displays the baseline EMCON plan he employs. He labels this plan BASELINE.

The E.W. Officer may retrieve the characteristics of any particular type of radar with the LIST, DETAILS, RADAR command, and may retrieve the status of a specific radar on a particular ship with a LIST, JOINT command. Two such records are displayed and explained in Figs. 4.7 and 4.8.

Proceeding to the third and fourth steps in Table 4.1 for developing the EMCON plan, the E.W. Officer obtains the electronic characteristics of each equipment and compares the frequency ranges of the different pieces of equipment. The use of these procedures allow the E.W. Officer to avoid using radars which will interfere with one another. In addition, these procedures allow the E.W. Officer to catalog his electronic resources by frequency range, so that he may effectively use equipment that operates at frequencies for which enemy monitoring equipment is least effective. Performed manually, such frequency matching is a simple but tedious procedure. The E.W. Officer uses his aid to produce the frequency chart using the DISPLAY, FREQUENCY command. Figure 4.9 displays the frequency chart produced for the BASELINE EMCON plan. In the present example, it is assumed that these different emitters do not interfere with one another and that the enemy ESM equipment is equally effective over all frequency bands. Therefore, the information in these graphs will not effect the further evaluation of the candidate EMCON plans.

The following discussion is primarily concerned with Steps 5 and 6. In these steps the E.W. Officer examines the contribution that each piece of equipment makes to surveillance effectiveness and the information that it

```
  OFF,RAD=ALL,SHIP=KITTY HAWK
  LIST,RADARS,SHIP=ALL


KITTY HAWK
OFF:  SPS-1Ø                                                 OFF:  SPS-3Ø
OFF:  SPS-43                                                 OFF:  SPS-52

TRUETT
ON:  SPS-1Ø                                                  ON:   SPS-4Ø

BOWEN
OFF:  SPS-1Ø                                                 ON:   SPS-4Ø

HOLT HE
ON:  SPS-1Ø                                                  ON:   SPS-4Ø

SPRUANCE
ON:  SPS-4Ø                                                  ON:   SPS-55

NASTY
ON:  SPS-1Ø

CHICAGO
ON:  SPS-1Ø
ON:  SPS-3Ø                                                  OFF:  SPS-43
OFF: SPS-48                                                  ON:   SPS-52

OKLAHOMA CITY
OFF:  SPS-1Ø                                                 ON:   SPS-3Ø
ON:   SPS-43                                                 ON:   SPS-52

VIREO
OFF:  SPS-1Ø

WIDGEON
ON:  SPS-1Ø
  LIST,MIMICS,SHIP=KITTY HAWK
```

Figure 4.6. The Baseline EMCON Plan. In the alternative EMCON plan, "ALL OFF KIT," all radars on the Kitty Hawk are off. In all other aspects, the baseline plan and the ALL OFF KIT plan are identical.

```
LIST,DETAILS,RADAR= SPS-43

EMITTER:                              SPS-43
VACUUM RANGE (KM):                        416.7ØØØ
FREQUENCY RANGE (MHZ):                    3ØØ.ØØØØ TO       33Ø.ØØØØ
OPERATOR EFFICIENCY FACTOR LIMITS:          Ø.ØØ8Ø TO         Ø.Ø16Ø
EMITTER TYPE:                         AIR SEARCH
PLATFORM TYPE:                        SHIP
FLAG:                                 BL
ID NUMBER  3.                         EMITTER IS ON.
```

Figure 4.7. Data in EWAR Data Base Describing the Radar SPS-43

The vacuum range against a one square meter target in a vacuum is the range at which the probability of detection is 0.9 per sweep. The probability of detection in clear weather is approximately the same as in a vacuum. The operator efficiency factor is a conversion factor for converting probability of detection per sweep into probability of detection per second. The low figure applies when a single operator is monitoring the display. The high figure applies when a large number of operators are monitoring the display. The intervals for frequency range and operator efficiency define the operational limits for this kind of radar. Specific radars on a particular ship will have a single operating frequency and operator efficiency within these limits. This information is retrieved using the command shown in Fig. 4.8. The SPS-43 is listed as being on because at least one SPS-43 in the Task Force is emitting.

```
LIST,JOINT,SHIP=TRUETT,RADAR=SPS-1Ø

TRUETT                                         SPS-1Ø

ANTENNA HEIGHT (KM):          Ø.Ø232
FREQUENCY (MHZ):            173.2464
EMITTER IN ON.
NUMBER OF OPERATORS:               1
VALIDITY TIME (SEC):        214.Ø83Ø
```

Figure 4.8. Data in EWAR Data Base for the SPS-10 on Ship Truett

Unlike the data in Fig. 4.7 which apply to a radar type, the data in this figure apply to a specific radar on a particular ship. The number of operators determines the specific operator efficiency conversion factor chosen from within the range indicated in the radar type record. Since this number is one, the conversion factor used in this case is the lowest number in the range.

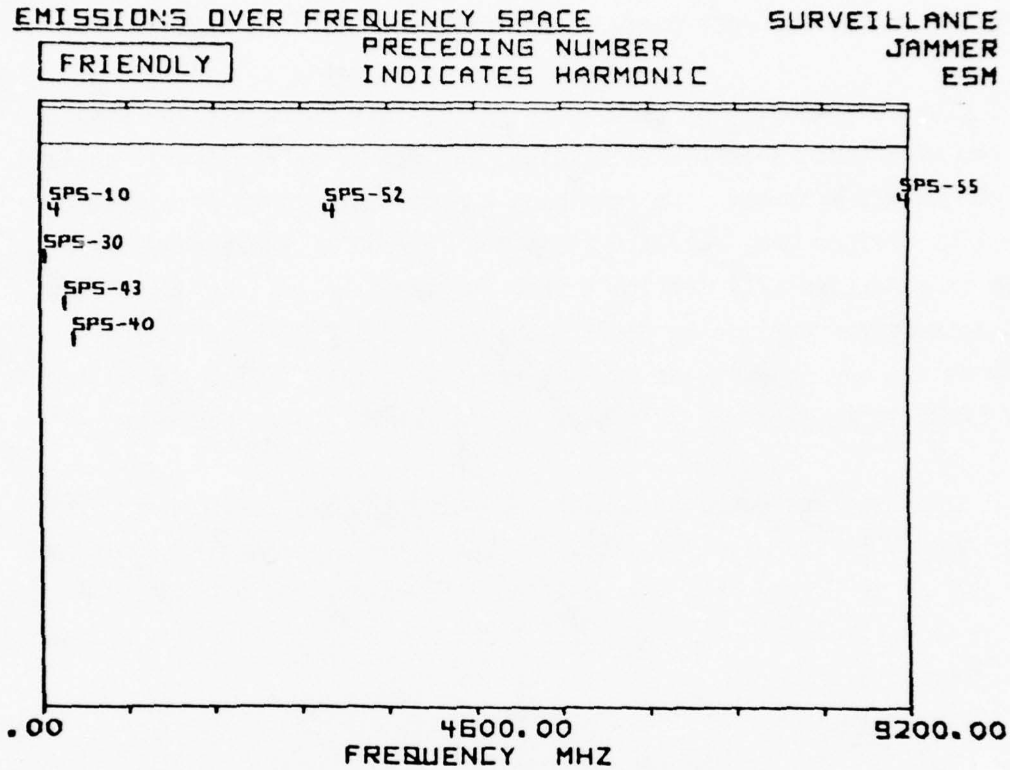

Figure 4.9. Emissions Spectrum

This chart includes all radars in the data base. The range extends over the first harmonic for all Task Force radars. The user may narrow the range to examine a portion of this chart in more detail or he may expand it to include additional harmonics. Several of the radars appear to be marked by the number "4." The horizontal line in each "4" is the permissible operations range for that radar type. The short vertical line marks the bottom of this range, while the longer vertical line marks the frequency of a currently emitting radar. This chart includes only friendly ships. Displays for neutral and hostile ships are also available. The type of radar, surveillance, jammer, or ESM is coded by the color. The color code is indicated by the color of the words "SURVEILLANCE," "JAMMER," AND "ESM," in the upper right hand corner.

reveals about the Task Force. Table 4.2 breaks down the steps into the detailed set of questions that must be addressed to determine the most suitable status for each piece of equipment.

The contribution of each radar to the Task Force mission depends on the other radars that are emitting, on Task Force configuration, and on the expected threat. In examining a particular piece of equipment, the E.W. Officer must evaluate it in the context of these other factors. This is a particularly difficult task for the E.W. Officer using existing methods for evaluating EMCON plans and the E.W. Officer may have to rely on his own judgment as to what the best status is for the equipment. The EWAR aid is intended to assist him in making these judgments.

Now the Task Force Commander has asked the E.W. Officer to evaluate two EMCON plans, a baseline plan, and a similar plan in which no radars on the carrier Kitty Hawk are emitting. Therefore, in applying the steps in Table 4.2, the E.W. Officer will treat the four emitters on the Kitty Hawk as a single group.

The E.W. Officer begins his analysis of surveillance effectiveness by examining surveillance coverage displays for a threat at an altitude of 0.05 km and a velocity of 300 m/sec (Figs. 4.10 and 4.11). The threat specified by the Commander includes a fighter-bomber flying at this altitude and speed. The dark circle in Fig. 4.10 surrounds the Kitty Hawk. The figure shows that there are no gaps in the Kitty Hawk air defense when the Kitty Hawk radars are emitting or when they are turned off. The figure is somewhat confusing because the number of circles is large. The information in Fig. 4.10 is replotted for the baseline plan as detection rate probabilities in Fig. 4.11. The figure shows that the radar coverage about the Kitty Hawk is relatively uniform with slightly better coverage to the south and southwest. Ships 7 and 8, the Widgeon and the Vireo, seem vulnerable to attacks from the east.

TABLE 4.2

STEPS FOR ASSESSING PROS AND CONS
OF RADIATION FOR EACH PIECE OF EQUIPMENT

1. Assess its contribution to surveillance effectiveness.
   - Can the emitter fill any gaps in radar coverage?
   - Does it significantly increase the probability of detection of the threat?
   - Does it significantly change the outcome of a "complete information" simulated strike?

2. Assess the ship identity information it reveals.
   - Does it uniquely identify a ship, or substantially narrow the number of ships that any particular ship could be confused with?
   - Will it significantly increase the probability that an enemy can correctly identify the important ships?
   - Does it significantly affect the overall amount of information given away?

3. Weigh the change in surveillance effectiveness against the change in information given away.
   - Given the expected probability of attack, will the candidate radar increase Task Force security?
   - Does it significantly change the outcome of an "incomplete information" simulated strike?

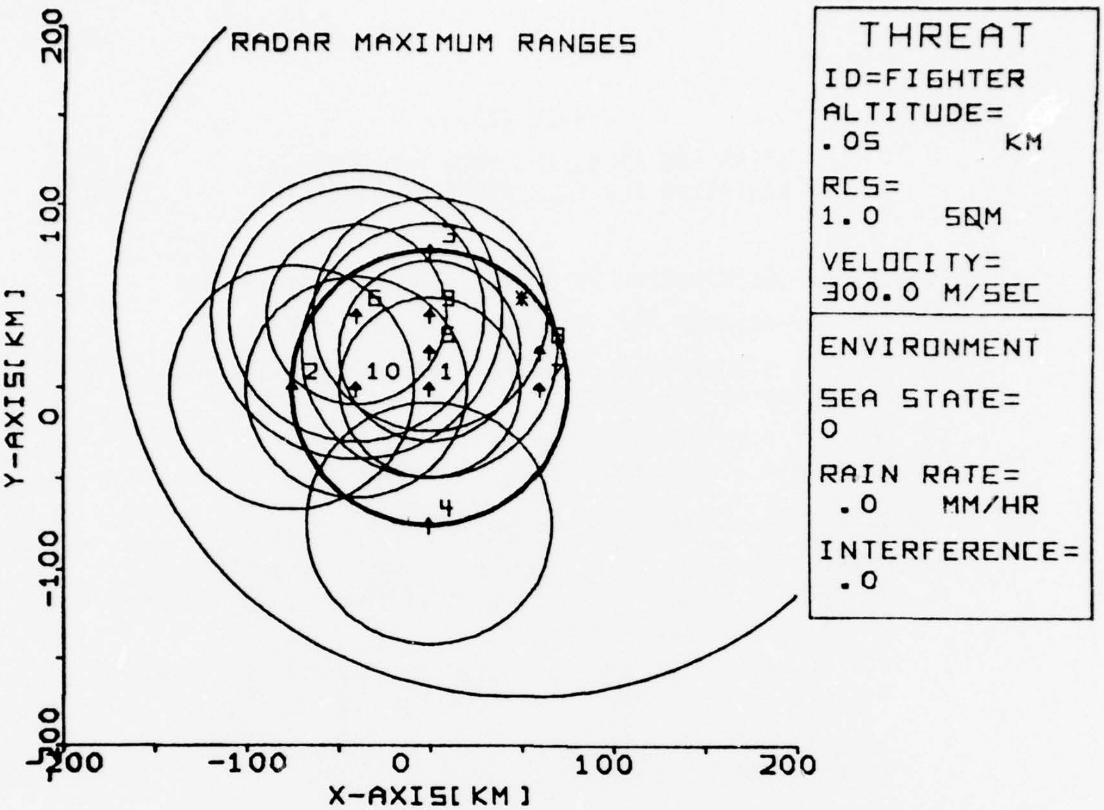

Figure 4.10. Emitter Ranges

Each circle indicates the threat-dependent maximum range of each radar presently in operation. Note the very large circle indicating the maximum range of the one emitting airborne radar. The dark circles surrounding the Kitty Hawk, ship number 1, result from the superposition of four emitting radar range circles. The table at right details some information on the incoming threat--its identification, altitude, radar cross section, and velocity. Environmental factors are listed also--sea state, rain rate, and the ratio of electronic to thermal interference. For the low altitude threat considered here the radar ranges are horizon limited.

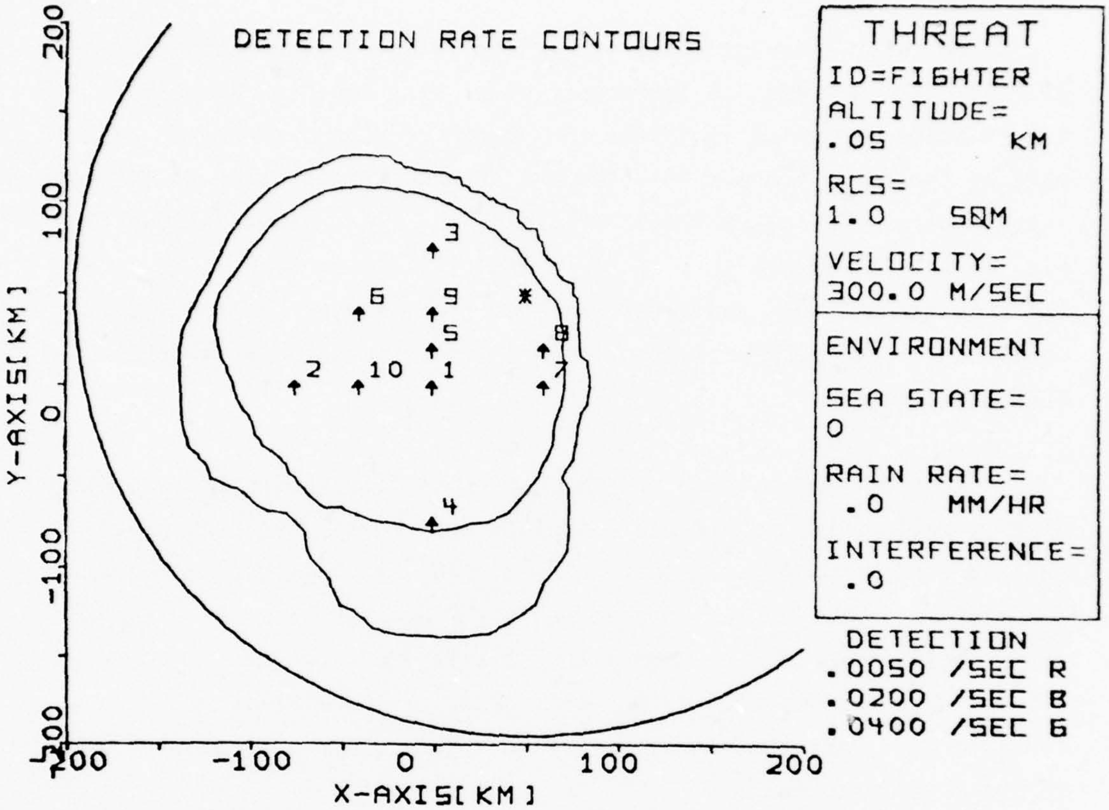

Figure 4.11. Detection Rate Contours for Baseline EMCON Plan

These contours indicate the probability of detection per second for the threat and environmental conditions listed on the right. An aircraft flying along the outer circle would on the average be detected in 200 seconds. One flying along the middle contour would be detected in 50 seconds and one along the inner contour in 20 seconds. Although it is difficult to determine from this graph the absolute probability of detection for the threat at any point, the display does show any weak spots in the radar coverage. A future display will plot cumulative probability of detection contours. The present display will remain useful for understanding the generation of these cumulative plots.

The radar coverage plots of Figs. 4.10 and 4.11 are elicited by DISPLAY, MAP commands. A third available radar coverage display is a gray-scale map which indicates the number of radars surveying each part of the key. The E.W. Officer did not use this display in evaluating his plan. The current weather status is listed and displayed in Fig. 4.12. The graphs in Figs. 4.10 and 4.11 depend both on threat--the attacker altitude and radar cross section--and on environmental conditions. Environmental conditions are set by the user through the WEATHER commands.

It is difficult to determine from these figures whether the Kitty Hawk is well protected because the plots do not show the probability that an attacker will be detected. A display showing cumulative probabilities of detection will be added to the aid shortly. At present the effectiveness of the surveillance coverage can be determined by simulating a strike against the Task Force. Enemy strikes in which the attackers know the identity of each ship provide a measure of surveillance effectiveness.

To avoid unnecessary complexity in the aid, the calculation of strike outcomes has been kept as simple as possible. The user need only provide values for a number of adjustable parameters such as radar operator efficiency and estimated air defense effectiveness to fully characterize the strike. Although the outcome calculator is rather simple, it shows differences between EMCON plans reasonably well. A user can calibrate the strike simulation by adjusting the strike parameters for a standard or baseline strike. These same parameters should then be used to generate the outcomes for all other strikes.

Figures 4.13 and 4.14 show the outcomes for the perfect information air strike (SHIPINF) specified by the Task Force Commander. Turning off all radars on the Kitty Hawk has decreased the surviving value of the Task Force from 0.26 of its original value (Fig. 4.13) to 0.233 (Fig. 4.14).

```
LIST,WEATHER

SEA STATE:                                                Ø
RAIN RATE--(MM/HR):                                       Ø.ØØØØ
ELECTRONIC OVER THERMAL  NOISE RATIO:                     Ø.ØØØØ
```

Figure 4.12. Environmental Factors

Changing environmental factors affect the capability of search radars. These factors are simulated with the WEATHER and LIST, WEATHER command. The sea state is an integer from zero to eight representing the Douglas sea number. Rain rate is in millimeters per hour. This parameter may also be used to simulate fog. The interference ratio simulates white omnidirectional interference due, for example, to hostile jamming.

```
SVSCORE,SHIPINF
                  FRACTIONAL VALUE REMAINING = .26Ø
                  STRIKE=        SHIPINF
                  EMCON PLAN=    BASELINE
  LIST,OUTCOME,STRIKE=SHIPINF,THREAT=ALL
STRIKE:     SHIPINF
EMCON PLAN: BASELINE
```

THREAT	SHIP	ALLO-CATION	# HITS	FRACTION REMAIN	SHIP VALUE INIT	SHIP VALUE REMAIN
FIGHTER	KITTY HAWK	4	39.3	Ø.43	939.5	4Ø1.7
	SPRUANCE	1	1Ø.8	Ø.21	9Ø.7	18.8
	TRUETT	1	9.4	Ø.17	47.7	7.9
	CHICAGO	2	19.2	Ø.22	2Ø3.5	44.8
	OKLAHOMA CITY	2	18.8	Ø.19	174.4	33.5
TOTALS:		1Ø	97.5	--	1559.6	61Ø.7
BOMBER	KITTY HAWK	1	26.5	Ø.49	939.5	46Ø.Ø
TOTALS:		1	26.5	--	1559.6	1ØØØ.1
GRAND TOTALS:		11	124.Ø	--	1559.6	4Ø5.6

Figure 4.13. Strike Outcome for BASELINE EMCON Plan

The SVSCORE command calls the strike and displays the outcome, of 0.260, the fractional value of the Task Force remaining after the strike. The LIST, OUTCOME, command displays the results of the strike in more detail. It lists the number of hits on each ship by each threat type. The totals refer to totals for each threat type. The grand total applies to the attack as a whole. For example, the fighter threat would leave 0.43 of the Kitty Hawk value intact were the strike to consist only of this threat while the bomber would leave 0.49 of the Kitty Hawk value in a pure bomber strike. Together they leave (0.43)(0.49) = 0.21 of the Kitty Hawk value intact.

```
SVSCORE,SHIPINF
                  FRACTIONAL VALUE REMAINING = .233
                  STRIKE=        SHIPINF
                  EMCON PLAN=    ALL OFF KH
  LIST,OUTCOME,STRIKE=SHIPINF,THREAT=ALL
STRIKE:     SHIPINF
EMCON PLAN: ALL OFF KH
```

THREAT	SHIP	ALLO-CATION	# HITS	FRACTION REMAIN	SHIP VALUE INIT	SHIP VALUE REMAIN
FIGHTER	KITTY HAWK	4	46.5	Ø.36	939.5	336.6
	SPRUANCE	1	1Ø.8	Ø.21	90.7	18.8
	TRUETT	1	9.4	Ø.17	47.7	7.9
	CHICAGO	2	21.1	Ø.17	2Ø3.5	35.2
	OKLAHOMA CITY	2	18.8	Ø.19	174.4	33.5
TOTALS:		1Ø	1Ø6.6	--	1559.6	535.9
BOMBER	KITTY HAWK	1	26.5	Ø.49	939.5	46Ø.1
TOTALS:		1	26.5	--	1559.6	1Ø8Ø.2
GRAND TOTALS:		11	133.1	--	1559.6	364.1

Figure 4.14. Strike Outcome for ALL OFF KH EMCON Plan

The increased effectiveness of the strike when Kitty Hawk radars are off reflects the decreased air defense with this EMCON plan. The strikes simulated in Figs. 4.13 and 4.14 assume the attack knows the true ship identity of each radar blip.

The detailed listings of the strike outcomes show that turning off the radars increased the number of hits on the Kitty Hawk from about 39 to about 46, and increased the fractional damage from 0.57 to 0.64. Note that the strike laydown remained the same in the two cases. This perfect information laydown did not depend on information given away because for these strikes the attacker knew the identity of all ships. Nevertheless, even for this type of attack, turning off the Kitty Hawk radars could have affected the laydown if the reduced air defense increased the vulnerability of the Kitty Hawk enough for an attacker to reallocate an attacker from another ship to the Kitty Hawk.

Having found that turning off the radars of the Kitty Hawk reduces the air defense of the Task Force very little, the E.W. Officer next uses the aid to explore the information consequences of turning off the radars. Turning off these radars particularly appeals to the Task Force Commander, for there is a possibility that this action may obscure the identity of the Kitty Hawk. The information given away displays are designed to estimate the extent to which such concealment occurs.

The command LIST, MIMICS, KITTY HAWK (Figs. 4.15a and 4.15b) lists all ships whose electronic order of battle permits them to mimic the emissions of the Kitty Hawk under the current EMCON plan. Of course, when none of the Kitty Hawk radars are emitting, any ship in the Task Force can mimic the Kitty Hawk simply by turning off all of its radars (Fig. 4.15b). The baseline EMCON plan (Fig. 4.15a) has all Kitty Hawk radars emitting--the SPS-10, SPS-30, SPS-43, and SPS-52. Since the only other ships which include all of these radars in their order of battle are the Chicago and Oklahoma City, only these ships and the Kitty Hawk can mimic the Kitty Hawk. The displays indicate that turning off the Kitty Hawk radars may considerably decrease an attacker's ability to identify the Kitty Hawk.

An attacker can draw inferences about Kitty Hawk identity from the ships that can mimic the Kitty Hawk, from the ships that the Kitty Hawk can mimic, and from the ships that can mimic the ships that can

SHIPS WHICH COULD MIMIC THE EMISSIONS OF KITTY HAWK

SHIP	CLASS	TYPE	VALUE
KITTY HAWK	KITTY HAWK	CARRIER	939.5
CHICAGO	ALBANY	CRUISER	2Ø3.5
OKLAHOMA CITY	CONVERTED CLEVELAND	CRUISER	174.4

Figure 4.15a. Ships which Can Mimic Kitty Hawk under Baseline EMCON Plan

Kitty Hawk has radars SPS-10, SPS-30, SPS-43, and SPS-52 emitting. The only other ships having these radars are the Chicago and the Oklahoma City.

SHIPS WHICH COULD MIMIC THE EMISSIONS OF KITTY HAWK

SHIP	CLASS	TYPE	VALUE
KITTY HAWK	KITTY HAWK	CARRIER	939.5
SPRUANCE	SPRUANCE	DESTROYER	9Ø.7
NASTY	NASTY	PT	1.Ø
TRUETT	KNOX	FRIGATE	47.7
CHICAGO	ALBANY	CRUISER	2Ø3.5
OKLAHOMA CITY	CONVERTED CLEVELAND	CRUISER	174.4
VIREO	BLUEBIRD	MINESWEEP	3.7
WIDGEON	BLUEBIRD	MINESWEEP	3.7
BOWEN	KNOW	FRIGATE	47.7
HOLT HE	KNOX	FRIGATE	47.7

Figure 4.15b. Ships which Could Mimic the Kitty Hawk when All Kitty Hawk Radars are Turned Off.

Since every ship can mimic Kitty Hawk in this state, this listing includes all Task Force ships.

mimic the Kitty Hawk. For example, if only the Chicago and Oklahoma City can mimic the Kitty Hawk and if the identity of both of these ships were known to the attacker, then the identity of the Kitty Hawk could be inferred. Quantitative ship-identity algorithms in the aid take into account these various inferences to give probabilities that any particular ship will be identified correctly or that a given ship will be identified as any other ship.

Figures 4.16a and 4.16b show the probabilities of correct identification for each ship in the Task Force for the two candidate EMCON plans. The probability of correctly identifying the Kitty Hawk has dropped from 426 to 109. Blip value is important because it is the value given by an attacker of attacking the ship corresponding to this blip. Blip value is the weighted average of the value of every ship which could correspond to the Kitty Hawk blip, the weights being the probabilities assigned by the attacker that the ships correspond to the Kitty Hawk blip. This substantial reduction in Kitty Hawk blip value when Kitty Hawk radars are turned off significantly affects the enemy targeting because in that case the Kitty Hawk appears to the enemy to be a relatively unimportant ship.

The displays shown in Figs. 4.17a and 4.17b indicate why the value of the Kitty Hawk blip drops so precipitously when its radars are turned off. Under the baseline EMCON plan the Kitty Hawk was confused principally with the Chicago and the Oklahoma City, but its blip was still given a fairly high value. When all its radars are turned off it is still likely to be confused with the Chicago and the Oklahoma City, but since it is even more likely to be confused with the Nasty, the Widgion and the Vireo, its probability of being correctly identified has become significantly smaller. (In practice such confusion with small ships would be less likely to occur if the enemy had information on radar echo size--but since effective countermeasures against conveying this information exist, it has not been incorporated into the present version of the aid.)

LIST,MIXUPS,ALL

SHIP NAME	ASSIGNED VALUE	PERCEIVED VALUE	PROBABILITY OF CORRECT ID SIDE	TYPE	CLASS	SHIP
KITTY HAWK	939.5	426.1	1.ØØ	.32	.32	.32
SPRUANCE	9Ø.7	81.9	1.ØØ	.88	.88	.88
NASTY	1.Ø	17.5	1.ØØ	.31	.31	.31
TURETT	47.7	47.1	1.ØØ	.98	.98	.33
CHICAGO	2Ø3.5	426.1	1.ØØ	.65	.32	.32
OKLAHOMA CITY	174.4	426.1	1.ØØ	.65	.32	.32
VIREO	3.7	18.Ø	1.ØØ	.61	.61	.31
WIDGEON	3.7	17.5	1.ØØ	.61	.61	.31
BOWEN	47.7	52.1	1.ØØ	.87	.87	.29
HOLT HE	47.7	47.1	1.ØØ	.98	.98	.33

Figure 4.16a. Probability of Correct Identification by Side, Type, Class, and Unit, for BASELINE EMCON Plan

Assigned values in this example are default ship values, ship displacement normalized to displacement of PT boat Nasty. Blip values are weighted averages of ship values. The weights are the probabilities of a given radar blip representing a particular ship. Note that several ships can be identified by class, but cannot be identified by unit within their class.

LIST,MIXUPS,ALL

SHIP NAME	ASSIGNED VALUE	PERCEIVED VALUE	PROBABILITY OF CORRECT ID SIDE	TYPE	CLASS	SHIP
KITTY HAWK	939.5	1Ø9.6	1.ØØ	.Ø8	.Ø8	.Ø8
SPRUANCE	9Ø.7	93.2	1.ØØ	.87	.87	.87
NASTY	1.Ø	1Ø9.7	1.ØØ	.24	.24	.24
TRUETT	47.7	49.Ø	1.ØØ	.98	.98	.33
CHICAGO	2Ø3.5	437.9	1.ØØ	.66	.33	.33
OKLAHOMA CITY	174.4	437.9	1.ØØ	.66	.33	.33
VIREO	3.7	1Ø9.6	1.ØØ	.47	.47	.24
WIDGEON	3.7	1Ø9.7	1.ØØ	.48	.48	.24
BOWEN	47.7	53.9	1.ØØ	.86	.86	.29
HOLT HE	47.7	49.0	1.00	.98	.98	.33

Figure 4.16b. Probability of Correct Identification by Side, Type, Class, and Unit, for ALL KH OFF EMCON Plan. Turning off the Kitty Hawk radars has reduced its blip value from 426.1 to 109.6 and its probability of correct ID from 0.32 to 0.08.

LIST,AMB,ALL

SHIP	IDENTIFIED AS	WITH PROBABILITY
KITTY HAWK	KITTY HAWK	.32
	CHICAGO	.32
	OKLAHOMA CITY	.32

Figure 4.17a. Ships which are Confused with the Kitty Hawk in the BASELINE EMCON Plan

Ships with a very low probability of being confused are not included in the printout. Those calculations assume that the enemy believes there is a 0.03 chance that his electronic order of battle information is incorrect.

LIST,AMB,ALL

SHIP	IDENTIFIED AS	WITH PROBABILITY
KITTY HAWK	KITTY HAWK	.Ø8
	NASTY	.24
	CHICAGO	.Ø8
	OKLAHOMA CITY	.Ø8
	VIREO	.24
	WIDGEON	.24

Figure 4.17b. Ships which are Confused with the Kitty Hawk in the ALL OFF KH EMCON Plan

The probability of correct identification has fallen from 0.32 to .008, and equally important, the Kitty Hawk is now likely to be confused with the very low-value ships Nasty, Vireo, and Widgeon. These low-value ships have few radars, and under the current EMCON plan, there are few ships they can mimic. Because the Kitty Hawk has all of its radars off, it is one of the few ships these low-valued ships can mimic. Therefore, the Kitty Hawk is likely to be identified as one of these ships.

The final information displays are the information-given-away scores of Figs. 4.18a and 4.18b. The two types of information summary scores are the classification and value scores. The score for the Task Force is the average of ship classification scores. A ship classification score is a weighted average of probability of correct ship identification by side, type, class and unit, for a particular ship. The value score is the cosine of the angle between the value vector and the blip vector with each component in these vectors corresponding to a ship. The classification score can reflect directly the user's judgment about the relative importance of correct identification by side, type, class, or unit. The value score depends wholly on ship value. This score assumes that an attacker targets by perceived value and that it is only through eliminating attacker errors in ship value that information improves attacker effectiveness. The value score indicates that turning off the Kitty Hawk has deceived the attacker. His assignment of blips to ships when weighted by ship value is worse than if there were no radar emissions at all. The classification score also indicates that the enemy loses much of his ability to target the Kitty Hawk after the Kitty Hawk radars are turned off.

The analysis of surveillance effectiveness and information given away suggests that turning off the Kitty Hawk radars increases the Task Force security. The E.W. Officer substantiates this impression by conducting the trade-off analysis of Step 3 in Table 4.1.

Figure 4.19 is a graph showing the weighted average of the information and surveillance scores as a function of the weight given to the information score. The outcome of a strike depends both on air defense and on attacker targeting information. When the user feels that air defense is more important, he will choose EMCON plans, whose weighted average of information and surveillance scores is large for weights > 0.5. When he feels that targeting information is more important, he will choose EMCON plans whose weighted average of information and surveillance scores is large for weights > 0.5. For example, if the E.W. Officer feels the attacker knows the identity of the major ships from sources other than

INFORMATION GIVEN AWAY SCORE	VALUE SCORE	CLASSIFICATION SCORE
ALL EMITTERS OFF	.5Ø	.21
CURRENT STATUS	.78	.49
ALL EMITTERS ON	.83	.62

Figure 4.18a. Information-Given-Away Scores for BASELINE EMCON Plan

These summary scores indicate how much information is given away under the current EMCON plan, compared with hypothetical limiting case plans in which all radars are emitting or no radars are emitting. Higher scores indicate more information is given away. A score of one indicates the identity of every ship in the Task Force is known. A score of zero indicates that no information, including the existence of the Task Force is available to an attacker. Because in the example it is assumed the enemy knows the Task Force composition and the electronic order of battle, the all-emitters-off scores are not zero. The value score is computed from ship and blip values while the classification score is computed from the probabilities of correct identification by side, type, class, and unit.

LIST,GIV

INFORMATION GIVEN AWAY SCORE	VALUE SCORE	CLASSIFICATION SCORE
ALL EMITTERS OFF	.5Ø	.21
CURRENT STATUS	.43	.36
ALL EMITTERS ON	.83	.62

Figure 4.18b. Information-Given-Away Scores for ALL OFF KH EMCON Plan

These scores indicate that turning off the Kitty Hawk radars deprives the attacker of a considerable amount of information. The very low value score implies the Kitty Hawk is hidden, and that an attacker has less than a random chance of correctly identifying the Kitty Hawk under this plan. The change in the classification score is smaller than the value score change because the value score weighs important ships more heavily than does the classification score.

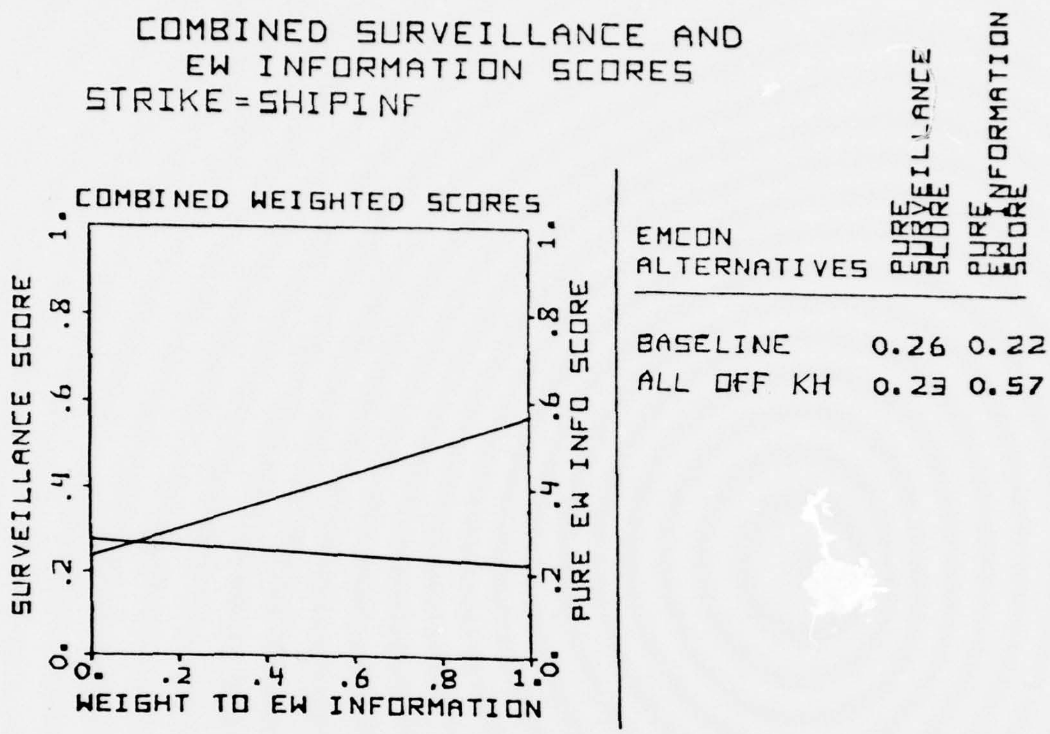

Figure 4.19. Trade-Off Analysis
The figure shows that the ALL OFF KH EMCON plan dominates the Baseline Plan in most situations in which maintaining the security of the Task Force is important. The pure EW information score is computed by subtracting the information-given-away value score from one. In moving across the display from left to right, the weight applied to EW information increases from 0 to 1, and the weight applied to the surveillance score decreases from 1 to 0.

the Task Force emissions, air defense becomes relatively more important than divulging further ship identity information. Therefore, the E.W. Officer will consider the rankings of plans to the left of the chart more important. On the other hand, if the E.W. Officer feels that a threat is so severe that air defense will be largely ineffective, then the Task Force may be best defended by denying the enemy targeting information. In that case, the rankings of the EMCON plans at the right of the chart may seem more important. Of the two EMCON plans considered, the radars-off plan is generally the more attractive.

Figure 4.19 ranks the two plans in a very general way. On the other hand, the strike simulator compares the two EMCON plans for a specific strike and attacker intelligence state. When the simulated strike is based on imperfect information, the outcome calculator complements the combined scores graph of Fig. 4.19 in the trade-off analysis. Figures 4.20a and 4.20b show the outcome for two attacks by the same strike, BLIPINF, when the two candidate EMCON plans are in effect. Turning off the Kitty Hawk radars results in the enemy not targeting the Kitty Hawk at all. As a consequence, the fraction of Task Force value remaining increases from about 0.45 to about 0.65. For this strike, at least, the tactic of turning off the Kitty Hawk radars is highly successful.

One reason for this success is that the enemy preferred to attack ships corresponding to blips that are less valuable than the blip corresponding to Kitty Hawk. They preferred this tactic because these ships were not in the center of the Task Force and were therefore not as well protected as the Kitty Hawk. On the other hand, an attacker may infer that any ship so well protected is likely to be valuable. To account for this possibility, the E.W. Officer was instructed to consider the effects of influences drawn from such information. He incorporates this additional information using the RESOLVE command. In this instance he decides that based solely on blip size and Task Force configuration the attacker will assume that the blip labeled number 1 in Fig. 4.1 is five times more likely to be the Kitty Hawk than is any other blip.

```
SVSCORE,BLIPINF
                    FRACTIONAL VALUE REMAINING = .449
                    STRIKE=        BLIPINF
                    EMCON PLAN=    BASELINE
  LIST,OUTCOME,STRIKE=BLIPINF,THREAT=ALL
STRIKE:     BLIPINF
EMCON PLAN: BASELINE
```

THREAT	SHIP	ALLO-CATION	# HITS	FRACTION REMAIN	SHIP VALUE INIT	SHIP VALUE REMAIN
FIGHTER	KITTY HAWK	3	29.5	Ø.53	939.5	496.8
	SPRUANCE	1	1Ø.8	Ø.21	9Ø.7	18.8
	CHICAGO	3	28.8	Ø.1Ø	2Ø3.5	21.Ø
	OKLAHOMA CITY	3	28.2	Ø.Ø8	174.4	14.7
TOTALS:		1Ø	97.2	--	1559.6	7Ø2.8
BOMBER	OKLAHOMA CITY	1	9.Ø	Ø.82	174.4	143.Ø
TOTALS:		1	9.Ø	--	1559.6	1528.2
GRAND TOTALS		11	1Ø6.2	--	1559.6	7ØØ.2

Figure 4.20a. Strike Outcome for BASELINE EMCON Plan when Attacker Can Use Only the Information Given Away by Electronic Emissions

```
SVSCORE,BLIPING
                    FRACTIONAL VALUE REMAINING = .657
                    STRIKE=        BLIPINF
                    EMCON PLAN=    ALL OFF KH
  LIST,OUTCOME,STRIKE=BLIPINF,THREAT=ALL
STRIKE:     BLIPINF
EMCON PLAN: ALL OFF KH
```

THREAT	SHIP	ALLO-CATION	# HITS	FRACTION REMAIN	SHIP VALUE INIT	SHIP VALUE REMAIN
FIGHTER	SPRUANCE	1	1Ø.8	Ø.21	9Ø.7	18.8
	TRUETT	1	9.4	Ø.17	47.7	7.9
	CHICAGO	3	31.7	Ø.Ø7	2Ø3.5	14.6
	OKLAHOMA CITY	3	28.2	Ø.Ø8	174.4	14.7
	BOWEN	1	8.8	Ø.21	47.7	1Ø.2
	HOLT HE	1	8.4	Ø.26	47.7	12.2
TOTALS:		1Ø	97.2	--	1559.6	1Ø26.5
BOMBER	WIDGEON	1	12.Ø	Ø.41	3.7	1.5
TOTALS:		1	12.Ø	--	1559.6	1557.4
GRAND TOTALS:		11	1Ø9.2	--	1559.6	1Ø24.3

Figure 4.20b. Strike Outcome for ALL OFF KH when Attacker Can Use Only the Information Given Away by Electronic Emissions

Since the surveillance effectiveness of the EMCON plans do not depend on ship identification, the analysis illustrated previously on surveillance is unchanged. The information-given-away results illustrated in Figs. 4.16, 4.17, and 4.18, have, however, changed substantially. The information-given-away score is now greater in the ALL OFF KH EMCON plan, (more information given away) than it was when all Kitty Hawk radars were emitting but the enemy used no additional information to infer ship identity (Fig. 4.21). Figure 4.22 reflects the value of this increased information to the outcome of the enemy strike. The E.W. Officer notes that the tactic of trying to hide the Kitty Hawk by turning off its radars no longer works and recommends to the Task Force Commander that if he believes that the enemy possesses such ship identity information, he should consider additional EMCON plans which stress air defense. On the other hand, if the enemy is not likely to have this additional intelligence, the ALL OFF KH EMCON plan is preferred to the BASELINE EMCON plan.

This section has illustrated how one E.W. Officer might have used the EWAR decision aid to evaluate an EMCON plan. The aid, however, can be used in different ways depending on the personal problem-solving style of the E.W. Officer and on the Task Force mission. Some officers may prefer to base their recommendations primarily on the data display features and to rely on their intuitive judgments about a plan's surveillance effectiveness or its effectiveness in denying information about the Task Force. Other officers may wish to use other displays to explore the surveillance and information consequences of a plan in greater detail in order to better understand the physical implications of the plan under different scenario assumptions. Finally, still other officers may use the full power of the aid by comparing the effectiveness of different candidate plans against assumed air strikes.

Because the EWAR decision aid is modular and hierarchical, it can adapt itself easily to such different styles. Therefore, DSA believes decision aids having the EWAR design philosophy will provide significant assistance to people with diverse decision styles engaged in a broad range of problems.

INFORMATION GIVEN AWAY SCORE	VALUE SCORE	CLASSIFICATION SCORE
ALL EMITTERS OFF	.93	.47
CURRENT STATUS	.84	.58
ALL EMITTERS ON	.99	.85

LIST,MIXUPS,ALL

SHIP NAME	ASSIGNED VALUE	PERCEIVED VALUE	PROBABILITY OF CORRECT ID SIDE	TYPE	CLASS	SHIP
KITTY HAWK	939.5	447.9	1.ØØ	.46	.46	.46
SPRUANCE	9Ø.7	86.6	1.ØØ	.87	.87	.87
NASTY	1.Ø	58.2	1.ØØ	.27	.27	.27
TRUETT	47.7	47.9	1.ØØ	.98	.98	.33
CHICAGO	2Ø3.5	35Ø.9	1.ØØ	.78	.39	.39
OKLAHOMA CITY	174.4	35Ø.9	1.ØØ	.78	.39	.39

Figure 4.21. Information-Given Away Scores and Probability of Correct Identification for ALL OFF KH Plan when Enemy Possesses Additional Intelligence.

```
SVSCORE,BLIPINF
                FRACTIONAL VALUE REMAINING = .247
                STRIKE=        BLIPINF
                EMCON PLAN=    ALL OFF KH
  LIST,OUTCOME,STRIKE=BLIPINF,THREATS=ALL
STRIKE:      BLIPINF
EMCON PLAN: ALL OFF KH
```

THREAT	SHIP	ALLO-CATION	# HITS	FRACTION REMAIN	SHIP VALUE INIT	SHIP VALUE REMAIN
FIGHTER	KITTY HAWK	4	46.5	Ø.36	939.5	336.6
	SPRUANCE	1	1Ø.8	Ø.21	9Ø.7	18.8
	CHICAGO	2	21.1	Ø.17	2Ø3.5	35.2
	OKLAHOMA CITY	3	28.2	Ø.Ø8	174.4	14.7
TOTALS:		1Ø	1Ø6.6	--	1559.6	556.8
BOMBER	KITTY HAWK	1	26.5	Ø.49	939.5	46Ø.1
TOTALS:		1	26.5	--	1559.6	1Ø8Ø.2
GRAND TOTALS:		11	133.1	--	1559.6	385.Ø

Figure 4.22. Strike Outcome for ALL OFF KH EMCON Plan when Enemy Possesses Additional Ship Identification Intelligence

ANNEX A
User Commands

A.1 COMMAND PROMPTS

The machine prompts for input "*" is the prompt used by subordinate subroutines, while "^" is the prompt used by the command executive.

ENTERING COMMANDS

Commands to EWAR are sequences of what shall be called strings together on a single line and separated from each other by commas. A string is either a single keyword or a parameter-option string. A parameter-option string consists of the parameter, or "PARM", followed by a mandatory delimiting "=" sign and an appropriate number of option words, each separated by a slash. Each keyword or parameter option string in a command specifies a different aspect of the command. In general, the first strings in a command guide the program to the subroutines needed for command implementation while the later strings specify the particular items to be processed.

THE PARAMETER-OPTION STRING

The general parameter-option string is:

Parameter = option 1/ option 2/ option 3/ . . . ./ option n

where n is between 1 and 5. The conventional "=" and "/" delimiters separate the parameter from the set of options and the options from each other, respectively.

AN EXAMPLE OF A COMMAND

The following command to insert ships into the EWAR data base illustrates the use of keywords and the parameter option string within a command. The command

INSERT, KITTY HAWK, POS = 20/20/KM, VAL = 1000

inserts the KITTY HAWK into the fleet, positions it 20 kilometers north and east of the designated origin and gives it a value of 1000. Note that the

two coordinates in the position parameter string are separated by a slash. The program would interpret POS = 20,20 as two separate strings--POS = 20 and 20. Since neither one is meaningful, the program would reject the command. Note also that VAL = 1,000 would be interpreted as VAL = 1 followed by the meaningless string 000.

CHANGING A PARTIALLY ENTERED COMMAND

Any command string within a command that begins with the character "%" is treated as a control rather than as a command. There are two such controls in the current EWAR model, %CANCEL and %REENTER.

Typing ",%CANCEL" or ",%C" anywhere in the command cancels the command and usually returns the program to the command executive. The program notifies the user whenever %C does not return control to the command executive.

Typing a ",%REENTER" or a ",%R" deletes the current incomplete command and a prompt "*" confirms to the user that the system expects the command to be reentered from the beginning.

Generally, the effect of any command the program cannot understand is the same as a %CANCEL. The user can cancel a command by typing nonsense followed by a carriage return. This is not recommended because the machine must waste time discovering it cannot understand the command and because the machine may in fact recognize the command.

Both CANCEL and REENTER commands void the current command. Their functions differ slightly. CANCEL is appropriate if the user decides he does not wish to exercise the current command function, but would rather switch to some other aspect of the aid. REENTER is appropriate when the user wishes to change information in the current command.

CONTINUING A COMMAND

The $ character anywhere in a command line causes the command string in which it appears and any subsequent strings on that line to be discarded and informs the program that the command is to be continued after the next carriage return. If desired, the "$" may be the only character in the string. The system expects the command to be continued on the next line from the first comma preceding the "$". Thus, the "$" is both a continuation character and a signal to discard the current command string. This is required whenever a command contains more than 80 characters because without the "$" the carriage return is the command terminator.

ABBREVIATIONS COMMANDS

All keywords and parameters containing more than four letters and most four letter words can be abbreviated by the first three letters of the keyword. Since the executive routines in EWAR contain lists of keywords to be matched against the user input, the program will accept only the full keyword or its three letter abbreviation. A mistyped keyword will generate an error message and cancel the command.

COMMAND DESCRIPTION CONVENTIONS

The following description of the EWAR command language uses the following conventions:

1. Words written in capital letters denote actual portions of command text; i.e., LIST, SHIPS.

2. Words in lower case denote a description of the item to be typed there; i.e., RADAR = one radar name. This refers to typing the name of exactly one radar.

3. Braces, { }, denote that exactly one of the enclosed options is to be picked; i.e., LIST, SHIPS, $\begin{Bmatrix} \text{ALL} \\ \text{OUT} \end{Bmatrix}$ denotes that either ALL or OUT is to be typed in the third string.

4. Brackets, [ ], enclose an optional string; i.e.,

LIST, RADARS [, SHIPS = ship names]

means that both LIST, RADARS and LIST, RADARS, SHIPS = a shipname are acceptable commands.

A.2 THE DISPLAY AND MODIFICATION OF THE TASK FORCE SCENARIOS

A.2.1 SHIPS AND AIRCRAFT

A.2.1.1 List Ships and Aircraft in Task Force

LIST, $\left\{\begin{matrix}\text{SHIPS}\\ \text{AIRCRAFT}\end{matrix}\right\}$ will list the names of all designated platforms presently in the fleet.

LIST, $\left\{\begin{matrix}\text{SHIPS}\\ \text{AIRCRAFT}\end{matrix}\right\}$, $\left\{\begin{matrix}\text{ALL}\\ \text{OUT}\end{matrix}\right\}$ platforms presently in the data base. platforms presently in the data base and NOT in the fleet.

LIST, SHIPS $\left[, \left\{\begin{matrix}\text{ALL}\\ \text{OUT}\end{matrix}\right\}\right]$ $\left[\text{,RADAR = one name} \left[/ \left\{\begin{matrix}\text{ON}\\ \text{OFF}\end{matrix}\right\}\right]\right.$ lists the names of all the ships of the specified status equipped with the given emitter. If the $\begin{matrix}\text{ON}\\ \text{OFF}\end{matrix}$ option is specified only ships with the given emitter in that status will be listed.

LIST, AC $\left[, \left\{\begin{matrix}\text{ALL}\\ \text{OUT}\end{matrix}\right\}\right]$ $\left[\text{,RADAR = one name} \left\{\begin{matrix}\text{ON}\\ \text{/OFF}\end{matrix}\right\}\right]$: same as above, but for AIRCRAFT platforms.

A.2.1.2 Modify a Ship in the EWAR Data Base
REACTIVATE A SHIP IN THE EWAR DATA BASE.

$$\text{INSERT} \left[, \text{SHIP}\right], \text{a ship name} \left[, \text{RADARS} = \begin{Bmatrix} \text{SET} \\ \text{ON} \\ \text{OFF} \end{Bmatrix}\right]$$

$$\left[, \text{POSITION} = \text{x coordinate/y coordinate} \left[\text{/units}\right]\right]$$

$$\left[, \text{VALUE} = \text{the value}\right] \left[, \text{HARDNESS} = \text{the hardness}\right]$$

The order for RADARS, POSITION, VALUE, and HARDNESS options is arbitrary. During the command processing the program will request the user to specify POSITION and RADAR options if not previously specified in the command. The program will ask

$$\textit{GIVE} \begin{Bmatrix} \textit{POSITION} \\ \textit{RADARS} \end{Bmatrix} \textit{OPTION}$$

and will follow the request with a prompt "*".

For RADARS the user responds with SET, ON, or OFF. ON and OFF turn radars aboard the specified ship on or off. SET permits the user to set the status of each radar individually. In that case, the program requests this information with a *give status* of a *radar name*. The user responds with an ON or OFF. The default is SET.

For POSITION the user must specify position using the format x coordinate, y coordinate [, units]. The default units are nautical miles.

The program will not ask for the VALUE or HARDNESS options. If the user does not specify these options in the insert command the program assumes these are to remain unchanged. Value and hardness can be independently changed using the VALUE and HARDNESS commands.

REACTIVATE AN AIRCRAFT.

INSERT, AC, aircraft name

The position of the aircraft is set separately using the POSITION command.

REMOVE A SHIP OR AIRCRAFT FROM ACTIVE PARTICIPATION IN THE EWAR SCENARIO.

DELETE, SHIP , ship name

DELETE, AC, aircraft name

A.2.1.3 Display Position of Ships

The positions of ships in the task force may be displayed by the command:

DISPLAY, MAP, POSITION, CENTER = x point/y point,
ENTER = distance

(Extent is the distance from the center over which a display is desired.)

A SHIP is denoted by the symbol: ↑
An AIRCRAFT is denoted by the symbol: *

A.2.1.4 Change Position of Ships

$$\text{POSITION, } \left\{ \begin{matrix} \text{SHIP} \\ \text{AIRCRAFT} \end{matrix} \right\} = \text{platform name, X,Y [,Z] [, units]}$$

The position command moves the designated ship or aircraft. Moving an aircraft requires the specification of its altitude. The default units are at present, kilometers (KM).

Example: POS, SHIP = BOWEN, 10, 20
POS, SHIP = TRUETT, 10000, 30000, M
POS, AC = HAWKEYE A, 30, 30, 3.

The examples move the Bowen to: X = 10, Y = 20
the Truett to: X = 10, Y = 30
the Hawkeye aircraft to: X = 30, Y = 30, Z = 3 (altitude)

A.2.1.5 List Characteristics of Ships and Aircraft

LIST, DETAILS, $\left\{ \begin{array}{l} \text{SHIP = a ship name} \\ \text{AIRCRAFT = an aircraft name} \end{array} \right\}$

The commands list the contents of the particular data base record requested.

A.2.1.6 Change Ship Value of Hardness

VALUE, ship name, new value parameter
HARDNESS, ship name, new hardness parameter

Example: VALUE, KITTY HAWK, 1040

These two commands are straightforward. Changes can be made on only one ship at a time. The system will request verification before making the change permanent. The example changes the value of the Kitty Hawk to 1040.

A.2.1.7 Change Complement of Ships and Aircraft in EWAR Data Base INSERT SHIPS FROM THE ONR DATA BASE INTO THE EWAR DATA BASE.

MODE, RETMOD
(Insert first ship)
(Insert second ship)
(Insert last ship)
MODE, RUN

Comments: MODE, RETMOD closes the EWAR data base and opens the ONR data base. MODE, RUN closes the ONR data base and opens the EWAR data base.

Each ship is inserted separately with the following command:

$$\text{INSERT} \left[\text{, SHIP}\right]\text{, a ship name} \left[\text{, RADARS} = \left\{\begin{array}{c}\text{ON}\\ \text{OFF}\\ \text{SET}\end{array}\right\}\right]$$

$$\left[\text{, POSITION = X coordinate/y coordinate} \left[\text{/units}\right]\right.$$

$$\left[\text{, VALUE = the value}\right] \left[\text{, HARDNESS = the hardness}\right]$$

The order for RADARS, POSITION, VALUE and HARDNESS options is unimportant. During the command processing the program will request the user to specify the appropriate parameter values for those not previously specified in the insert command. The program will ask

$$\mathit{GIVE} \left\{\begin{array}{c}\text{RADARS}\\ \text{POSITION}\\ \text{VALUE}\\ \text{HARDNESS}\end{array}\right\} \mathit{OPTION}$$

and will follow the request with a Prompt "*". For VALUE AND HARDNESS and RADARS, the user responds with a single word or number or with a carriage return. A carriage return alone instructs the program to supply a default value.

DEFAULTS: RADARS: SET

VALUE: ship displacement normalized with respect to the PT-Boat NASTY

HARDNESS: ship value

There is no default for POSITION. The response to the prompt is:

x position, y position [, units]

Comments:

1. Note that commas separate the coordinates here, whereas slashes separate them in the INSERT command itself.

2. In the radar RADARS option, ON turns on every radar on ship; OFF turns off all radars. SET causes the program to ask the user to specify the status of each radar on the ship separately. The program will request this information with a *GIVE STATUS OF the relevant radar* followed by a prompt. The user responds with ON or OFF.

3. Occasionally the program will retrieve from the ONR data base a ship whose type is not specified by this data base. In that case it will ask the user to specify the ship type.

4. All ship radars are classified as air search, sea search, jammers, or radio. Usually the program can classify each radar from its description in the ONR data base. If not, the program will ask *GIVE FUNCTION (A, S, J, R) of radar name* followed by a description of the radar and a prompt. The user should specify A, S, J, or R, corresponding to an air search, sea search, jammer, or radio, respectively.

5. If the user tries to insert a ship already known to the EWAR data base, the program will ask if he wishes to override the EWAR data. If not, the ONR data is ignored.

6. All ships newly inserted into the EWAR data base are active in the fleet. A ship can be inactivated by the DELETE command.

PERMANENTLY PURGE A SHIP FROM THE EWAR DATA BASE.

PURGE, [SHIP], ship name

A.2.2 RADARS AND EMCON PLAN

A.2.2.1 List Radars in Task Force

LIST, RADARS lists the names of all emitters in the data base and their status. ON status is given those emitters turned on somewhere in the fleet. OFF status is given those emitters not on anywhere in the fleet. This status is also given to those emitters which are not equipment on any platform presently in the fleet.

LIST, RADARS, $\begin{Bmatrix} \text{ALL} \\ \text{ON} \\ \text{OFF} \end{Bmatrix}$ lists the names of all emitters with the given

status. The command LIST, RADARS, ALL results in the same action as the command LIST, RADARS.

A.2.2.2 List the Current EMCON Plan

$$\text{LIST, RADARS}\ \left[,\ \begin{Bmatrix}\text{ON}\\ \text{OFF}\end{Bmatrix}\right],\ \begin{Bmatrix}\text{SHIP}\\ \text{AC}\end{Bmatrix} = \begin{Bmatrix}\text{ALL}\\ \text{one to five names}\end{Bmatrix}$$

This command lists all emitters with the specified status option on the requested platform. If ALL is specified in the SHIP or AC option, the list will include only ships active in the task force or aircraft on station. To list the radars on an inactive platform the user must type the name of the platform explicitly. The ALL platform option and specific names may not be used in the same command. The current EMCON plan is most conveniently displayed using the commands:

LIST, RADARS, SHIP = ALL
LIST, RADARS, AC = ALL

A.2.2.3 Change and Rename the EMCON Plan

The ON and OFF commands are used to change the status of emitters. These commands change the status of each specified radar on each specified ship. The format is:

$$\begin{Bmatrix}\text{OFF}\\ \text{ON}\end{Bmatrix},\ \left\{\text{RADAR} = \begin{matrix}\text{ALL}\\ \text{1 to 5 names}\end{matrix}\right\}\ \left[,\ \begin{Bmatrix}\text{TYPE}\\ \text{CLASS}\\ \text{SHIP}\\ \text{AIRCRAFT}\end{Bmatrix} = \begin{Bmatrix}\text{ALL}\\ \text{1 to 5 names}\end{Bmatrix}\right]$$

or

$$\begin{Bmatrix}\text{OFF}\\ \text{ON}\end{Bmatrix},\ \begin{Bmatrix}\text{TYPE}\\ \text{CLASS}\\ \text{SHIP}\\ \text{AIRCRAFT}\end{Bmatrix} = \begin{Bmatrix}\text{ALL}\\ \text{1 to 5 names}\end{Bmatrix}\ \left[,\ \text{RADARS} = \begin{Bmatrix}\text{ALL}\\ \text{1 to 5 names}\end{Bmatrix}\right]$$

The ON/OFF command contains two possible parameter-option strings: a RADAR string, and a platform string. One or the other must be included, but the third string is optional. If the RADAR string is left out of the command, it is assumed to be "RADAR = ALL." If the ship string is omitted, it is assumed to be "SHIP = ALL." (Radars aboard aircraft are therefore unaffected.)

Instead of specifying "ALL" in the option strings, one may list the names of up to five radars or platforms. The command format permits lists by ship type or class as well as by unit name.

The command will not change the status of any specified radar already having the desired state.

Example: ON, SHIP = ALL, RAD = SPS-10/SPS-20

The example would turn on all SPS-10's and SPS-20's aboard every ship.

Should some of the platform or radar names be unrecognized, the aid will notify the user of those names not recognized, but will process those it can recognize.

The EMCON command is used to change the current EMCON plan name. Its format is:

EMCON, name

The parameter "name" is a string of alphanumeric characters which identify the current EMCON plan. It may contain up to thirty characters although, in some displays, only the first ten are output.

A.2.2.4 List the Details of a Radar

The command

LIST, DETAILS, RADAR = a radar name

lists the characteristics of the radar type specified. The radar status is listed as "ON" in this output if it is emitting on even one ship.

The command

$$\text{LIST, JOINT,} \left\{ \begin{array}{l} \text{SHIP} \\ \text{AIRCRAFT} \end{array} \right\} = \text{one name, RADAR = one name.}$$

lists those characteristics of a radar unique to the specified platform.

A.3 THE DISPLAY AND MODIFICATION OF THE THREAT

A.3.1 DISPLAY THE THREAT

A threat is an enemy attack capability. It consists of a number of attacking aircraft having a particular speed, altitude, and cross section and carrying a weapon with a particular yield, CEP, weapon range, and average effectiveness. The command

LIST, THREATS:

lists the names of all presently known THREATS.

The command

LIST, DETAILS, THREAT = one name:

lists the contents of the specified threat record.

A.3.2 SPECIFY AN ENEMY THREAT

The THREAT command creates a new threat record or alters a current one. A threat record specifies attacker characteristics as deployed against the task force. The command format is:

THREAT, IDENT = name [,parameter 1 = list 1]. . .[,parameter n = list n]
IDENT - alphanumeric (1-20 characters) identifier of the threat

Permissible additional parameters are listed below:

ALTITUDE = value [/units]
RCS = value (cross section in square meters)

VELOCITY = value [/units]

YIELD = value (yield of weapon)

CEP = horizontal radius/vertical radius [/units] (weapon has 50% probability of striking within the elipse defined by these CEP parameters)

WPNRADIUS = value [/units] (effective range of the weapon carried by the threat)

NWEAPONS = value (number of weapons carried by the threat)

In almost all cases, the user will not wish to specify all parameters in the initial command. IDENT is required; however, other parameters not specified will be requested by the decision aid. For example, the following prompt might be issued:

$$\textit{VELOCITY} = ? \quad \left\{ \begin{array}{l} \text{value [, units]} \\ \text{DEF} \\ \text{<CR>} \end{array} \right\}$$

User may enter a new value (note use of commas here in place of slashes,) "DEF" for the default value or a carriage return, <CR>, to leave the value as it is presently in the data base.

In addition, a user may purge an existing record entirely. This must be used with caution because the threat names in the attacker list of the strike records are not deleted by the purge command. The syntax is:

THREAT, IDENT = name, PURGE

A.3.3 DISPLAY A SPECIFIC ENEMY STRIKE CHARACTERISTIC

A strike record is an attack on the Task Force. Each strike consists of a set of attackers (THREAT parameter), a rule for assigning these attackers to individual ships (LAYDOWN parameter) and guidelines limiting the direction of attack (BEARING parameter.)

LIST, STRIKES lists the names assigned to all presently known strike plans.

LIST, JOINT, $\begin{matrix}\text{SHIP}\\ \text{AIRCRAFT}\end{matrix}$ = one name, THREAT = one name

will retrieve information about a particular threat as it applies to the given platform.

The following command is used to list the details in a strike record. Refer to the DISPLAY option of the STRIKE command for details on the use of the 3 listed options.

LIST, DETAILS, STRIKE = strike name, one of the 3 options below

1. THREATS $=\begin{Bmatrix}\text{name}\\ \text{ALL}\end{Bmatrix}$

2. LAYDOWN, THREATS $=\begin{Bmatrix}\text{ALL}\\ \text{name}\end{Bmatrix}$, SHIP $=\begin{Bmatrix}\text{name}\\ \text{ALL}\end{Bmatrix}$

3. PLAN

A.3.4 SPECIFY AN ENEMY STRIKE

The STRIKE command creates a new strike record or alters an existing one. The complete specification of a strike normally requires a sequence of commands. The initial command places the aid in a "strike-establishment mode" and accepts one threat, laydown, and bearing specification. The aid remains in this mode until the user types on EXIT. While in the strike

establishment mode the machine confirms each strike-defining command with an

OTHER COMMANDS?

The general procedure for establishing a strike record is:

STRIKE ESTABLISHMENT COMMAND

ADDITIONAL DEFINING COMMANDS AND
RECORD DISPLAY COMMANDS

STRIKE EXIT COMMAND

This sequence can be simplified when the user selects an automatic laydown and bearing assignment. In that case, the command sequence is:

STRIKE ESTABLISHMENT COMMAND
THREAT COMMANDS
ONE LAYDOWN COMMAND
ONE BEARING COMMAND
STRIKE EXIT COMMAND

THE STRIKE ESTABLISHMENT COMMAND has the format

STRIKE, strike name $\left[,\left\{\begin{matrix}\text{PURGE}\\ \text{NEW}\end{matrix}\right\}\right]$ [,THREATS = option list] [, BEARING = option list] [LAYDOWN = option list]

The PURGE option deletes the named strike record entirely.

The NEW option is never required and is included only for suppression of certain queries from the aid which occur if it does not recognize the named strike.

The specification of the three main attributes of a strike record, THREATS, LAYDOWN, and BEARING are described below:

THREATS

The first attribute is a list of threats which comprise the strike. The threat names in the list must have been previously specified in a THREAT command. The option list is as follows:

THREATS = threat name/number

The named threat will be <u>added</u> to the list. No more than one threat may be entered in the original STRIKE command string. However, once the user has entered the STRIKE record routine he is given the opportunity to enter others interactively.

LAYDOWN

The LAYDOWN is a complete description of the allocation of the various threats to ships in the task force. It can take the form of a detailed manual allocation or the specification of rules or planning factors used by one enemy in developing his laydown.

$$\underline{\text{LAY}}\text{DOWN} = \left\{ \begin{array}{l} \underline{\text{OPS}}\text{HIP} \\ \underline{\text{OPB}}\text{LIP} \\ \underline{\text{SHI}}\text{PVAL} \\ \underline{\text{BLI}}\text{PVAL} \\ \underline{\text{MAN}}\text{UAL}/\left|\begin{array}{l}\text{threat name}\\ \text{ALL}\end{array}\right| / \left|\begin{array}{l}\text{ship name}\\ \text{ALL}\end{array}\right| / \text{ number [/azimuth]} \end{array}\right\}$$

OPSHIP - resulting laydown maximizes true damage to Task Force

OPBLIP - resulting laydown maximizes damage as estimated by the attacker based on his perceived values of the various blips

SHIPVAL - laydown for each threat is proportional to the true value of the ships

MANUAL - user specifies the laydown, one threat/ship combination at a time. Note the option to allocate a certain number of a given threat to all ships or vice versa.

number - number of threats of specified type allocated to specified ship

azimuth - azimuth of attack in degrees as measured counterclockwise from the X-axis. If the azimuth is not specified, the global planning factors for BEARING (see below) are in effect.

The aid will continue to prompt for additional threat/ship combinations until a single <CR> is entered, causing the processor to move on to ask for other commands. The response to these prompts should have the format.

threat name, ship name, number, [azimuth]

Note that the different components are separated by commas rather than by slashes.

BEARING

The BEARING option allows the user to select azimuths for the strike. Again, this can be a number of detailed manual specifications or global planning factors.

$$\text{BEARING} = \left\{ \begin{array}{l} \text{OPTIMAL [/blo/bhi/n]} \\ \text{AVERAGE [/blo/bhi/n[/}\gamma\text{]} \\ \text{MANUAL} \left\{ \begin{array}{l}\text{threat name} \\ \text{[ALL}\end{array} \right\} / \left\{ \begin{array}{l}\text{ship name}\\ \text{ALL}\end{array}\right\} \text{/ azimuth]} \end{array} \right\}$$

OPTIMAL - Attacker chooses the optimal azimuth for each threat/ship combination.

AVERAGE - Damage computation is averaged over a number of azimuths.

MANUAL - User chooses the azimuth. It is not necessary for him to specify the azimuth for every threat/ship combination, but a manual selection overrides any global parameters which have been set.

For OPTIMAL and AVERAGE, default values are used for parameters not specified. For MANUAL, one threat/ship combination at a time is entered. The aid will continue to prompt until a lone <CR> is input

blo - lowest azimuth to be allowed (0-360°)

bhi - highest azimuth to be allowed (0-360°)

n - the number of azimuths for which data are computed between blo and bhi, for the OPTIMAL and average.

γ - weighting parameter in the averaging. It is used to weight the average more or less favorably to the more vulnerable azimuths of attack. γ may have any positive value, and the resulting average is weighted in proportion to the damage raised to the power gamma. For example,

$\gamma = 0$; unweighted

$\gamma = \infty$; optimal

ADDITIONAL STRIKE-DEFINING COMMANDS

Once the user enters the STRIKE command, control is not returned to command level until he types "EXIT." In the meantime, the aid prompts with

OTHER COMMANDS?

It is suggested that users enter as little as possible in the initial strike command and let the aid prompt him through the various stages of the strike specification. At the *OTHER COMMANDS?* prompt the user may enter one of the following:

THREATS = option list
LAYDOWN = option list
BEARING = option list

RECORD DISPLAY COMMANDS

DISPLAY is used to display selected attributes of the current strike record to aid in further development. The results are similar to those obtained by,

LIST, DETAILS, STRIKE = strike name

Further information on the display options follow.

$$\text{DISPLAY,} \left\{ \begin{array}{l} \text{THREATS/options} \\ \text{LAYDOWN/options} \\ \text{PLANNING} \end{array} \right\}$$

$$\text{THREATS} \left| / \left| \begin{array}{l} \text{threat name} \\ \text{ALL} \end{array} \right| \right|$$

lists current entries in the threat list, the total number in strike and the number remaining unallocated.

$$\text{LAYDOWN} \left| / \left| \begin{array}{l} \text{threat name} \\ \text{ALL} \end{array} \right| / \left| \begin{array}{l} \text{ship name} \\ \text{ALL} \end{array} \right| \right|$$

lists numbers allocated and azimuth if specified.

PLANNING - results in a display of the current global planning factors:

LAYDOWN mode
BEARING , mode
, bls
, bhi
, n
, γ

EXIT COMMAND

EXIT results in an exit from the strike processor. At this time the user must indicate whether to make all changes permament (SAVE) or scrap the work (SCRAP).

$$\text{EXIT, } \begin{Bmatrix} \text{SCRAP} \\ \text{SAVE} \end{Bmatrix}$$

HELP COMMANDS

HELP is used to obtain assistance on available options and syntax.

$$\text{HELP, } \left[\begin{Bmatrix} \text{THREATS} \\ \text{LAYDOWN} \\ \text{BEARING} \\ \text{DISPLAY} \\ \text{IEXIT} \\ \text{HELP} \end{Bmatrix} \right]$$

A.3.5 SPECIFY AND LIST WEATHER CONDITIONS

LIST, WEATHER: will list the weather parameters current in effect.

The Weather Command alters the current status of weather and/or electronic interference. Its syntax is

WEATHER [SEA = I] [,RAIN = r] [INTERFERENCE = ρ]

I = Douglas sea number (0-8)

0 - very smooth

3 - moderate (4 ft waves)

5 - very rough (10 ft waves)

r = rainfall rate (mm/hr)

In addition to specifying rainfall rate, r can accommodate fog conditions. For example,

Visibility (meters)	Equivalent r
300	1.5
90	6.2
30	22.5

ρ = ratio of electronic interference to thermal noise. Condition which results is white omnidirectional interference due, for example, to hostile jamming.

Parameters can appear in any order and need not all be specified. If a parameter is not specified, the default value is used. Although each of the parameters is optional, this command does require that at least one be specified.

A.4.0 A DISPLAY FOR EMISSIONS CONTROL

$$\text{DISPLAY, FREQUENCY,} \left\{ \begin{array}{l} \text{LIMITS = freq 1.freq 2 /units} \\ \text{BAND = a band A-J} \end{array} \right\}$$

Example: DIS, FRE, BAND = C
DIS, FRE, LIM = 200/400

This command yields a display of radiating emissions and their harmonics over the designated frequency space. If no limits are specified, the lowest and highest values in the data base plus their harmonics (up to the default number) will be displayed. (The default display is generally difficult to interpret because of the resulting small scale.)

The default number of harmonics displayed is three. The user may change this number by using the default command with the parameter key word MXHARMONIC.

The BAND specification is equivalent to the frequency limits listed below.

BAND	LOW LIMIT	(MHz)	HIGH LIMIT
A	100.		200.
B	200.		500.
C	500.		1000.
D	1000.		2000.
E	2000.		3000.
F	3000.		4000.
G	4000.		6000.
H	6000.		8000.
I	8000.		10000.
J	10000.		20000.

A.5.0 SURVEILLANCE EFFECTIVENESS DISPLAYS

A.5.1 DISPLAY THE MAXIMUM RANGE OF EMITTING RADARS, THE OVERLAPPING RADAR COVERAGE, OR THE DETECTION RATE CONTOURS

$$\text{DISPLAY, MAP, } \left\{\begin{array}{l}\text{RANGES, THREAT = one name} \\ \text{COVERAGE, THREAT = one name} \\ \text{CONTOURS, THREAT = one name}\end{array}\right\},$$

CENTER = x point/y point, EXTENT = distance

(Extent is the distance from the center in each direction over which display is desired.)

"RANGES" shows the limits of coverage of each operating emitter.

"COVERAGE" displays the multiplicity of coverage using various shades of gray to create a spotlight effect.

"CONTOURS" displays the detection rate contours for the present emitter status.

A.5.2 COMPUTE THE SURVEILLANCE SCORE: RADAR EFFECTIVENESS AGAINST A SPECIFIC ATTACK WHERE THE ATTACKER KNOWS CORRECT SHIP IDENTITIES

When the enemy strike does not depend on information given away, strike effectiveness is a function only of threat characteristics and surveillance coverage. The surveillance capabilities of different EMCON plans can be scored by measuring their effectiveness in protecting the Task Force from a standard strike.

SVSCORE causes the surveillance score to be computed for the named strike and the current EMCON state. Its format is

SVSCORE, strike name

The output is the expected fractional damage to the Task Force. It is used as an overall measure of the surveillance effectiveness of the current EMCON plan against the threats and planning factors specified in the named strike.

The OUTCOME command details the factors contributing to a particular surveillance score generated by either the SVSCORE or SAVE, SCORE commands. This command lists threat allocation, hits sustained by ships from threats, fraction of each ship remaining as a result of damage sustained, and the initial value and value remaining of each ship.

Information can be generated regarding a single ship and a single threat, or about the whole fleet's endurance under attack by all threats.

Note that a strike must always be specified. The general command format is:

$$\text{LIST, OUTCOME, STRIKE} = \begin{matrix}\text{one}\\ \text{strike}\\ \text{name}\end{matrix}\text{, SHIP} = \left\{\begin{matrix}\text{ALL}\\ \text{1 to 5 names}\end{matrix}\right\}\text{, THREAT} = \left\{\begin{matrix}\text{ALL}\\ \text{1 to 5 names}\end{matrix}\right\}$$

A.6.0 DISPLAYS CONCERNING EW INFORMATION GIVEN AWAY

A.6.1 ENEMY INFORMATION CAPABILITIES

A.6.1.1 List Detailed Information About Ship Identification

The LIST, MIMICS command lists for each specified ship the other ships whose electronic order of battle would permit them to mimic the given ship under the current EMCON plan. Its format is:

$$\text{LIST, MIMICS, } \left\{\begin{array}{l}\text{SHIP}\\ \text{CLASS}\\ \text{TYPE}\end{array}\right\} = \text{name 1 [/name 2]. . .[/name n]}$$

The LIST, MIXUPS command lists for each specified ship its probability of correct identification by side, type, class, and unit, and gives the ship's classification score. It's format is:

$$\text{LIST, MIXUPS, } \left\{\begin{array}{l}\text{SHIP}\\ \text{CLASS}\\ \text{TYPE}\end{array}\right\} = \text{name 1 [/name 2]. . .[/name n]}$$

The classification score is the weighted sum

$$GSIDE * PSIDE * GTYPE * PTYPE * GCLASS * PCLASS + GID*PID$$

where PSIDE, PTYPE, PCLASS, and PID are respectively the probability of correct identification by side, type, class and unit. Parameters GSIDE, GTYPE, GCLASS and GID must sum to one. They may be user modified through the DEFAULT command. These default values are .1, .3, .5, and .1 respectively.

The LIST, AMBIGUITY command lists for each specified ship the probability to the attacker that it will be other specific ships. The command format is:

LIST FOR EACH SPECIFIED SHIP THE PROBABILITY THAT IT WILL BE IDENTIFIED AS OTHER SPECIFIC SHIPS.

$$\text{LIST, AMBIGUITY, } \left\{\begin{array}{l}\text{SHIP}\\ \text{CLASS}\\ \text{TYPE}\end{array}\right\} = \text{name 1} \left[\text{/name 2}\right] \ldots \left[\text{/name n}\right]$$

Only the ships most likely to be identified as the given ship will be listed. Those with a probability of such identification smaller than PIJMIN (modifiable by the user through the DEFAULT command) will be emitted.

A.6.1.2 Summarize Information Status

LIST, MIXUPS, ALL lists for each ship its probability of correct identification by side, type, class, and unit, and the value assigned to its corresponding radar blip by an attacker.

LIST, GIVEAWAY displays information scores. This command generates six scores, three "value" scores and three "classification" scores. The three scores in each category correspond to three EMCON plans: the current plan and the two bounding plans in which all radars are emitting or no radars are emitting.

The value score is computed by comparing the values assigned to the ships with the values of the corresponding radar blips assigned by the attacker.

The classification score is computed from the classification scores from all of the ships. Each ship classification score is described under the LIST, MIXUPS command in the previous section.

More valuable ships contribute more heavily to both value and classification scores than do less valuable ships. This contribution is linear with value for the classification score and varies approximately with the square of value in the value score.

A score of one signifies the attacker knows the identity of each ship. A score of zero indicates the attacker has no information about the task forces, not even its existence. The scores associated with all radars off reflect both user specified information available to the attacker as well as his knowledge of task force composition and electronic order of battle.

A.6.2 USER SPECIFIED ADDITIONAL SHIP-IDENTITY INFORMATION GIVEN TO AN ATTACKER

In the EWAR decision aid scenario an attacker always has the ship-identity information he can infer from the Task Force electronic order of battle and emissions. The RESOLVE commands permit the aid to reflect other kinds of ship-identity information acquired by an attacker. This information is entered using the RESOLVE commands. Its format is:

$$\text{RESOLVE, BLIP} = \left\{\begin{array}{l}\text{a ship name}\\ \text{SHIP/ a ship name}\\ \text{CLASS/ a class name}\\ \text{TYPE/ a type name}\end{array}\right\}$$

$$\left[\text{, SHIP} = \left\{\begin{array}{l}\text{a ship name}\\ \text{SHIP/ a ship name}\\ \text{CLASS/ a class name}\\ \text{TYPE/ a type name}\end{array}\right\}\right]\text{, FACTOR = a number}$$

Before the first use of the RESOLVE command, the factor for every blip-ship combination is 1. This case implies that an attacker will try to deduce the identity of each blip on his radar screen using only the signatures of radars emitting from each ship and his knowledge of the Task Force order of battle. The EWAR algorithm uses this information to predict how likely an attacker is to assign any particular blip to a particular ship. If a user feels an attacker has additional information relevant to ship identity, such as its position in the Task Force or interrupted radio communications, he can change the consideration the EWAR probability algorithm gives to any particular blip-ship combination by a factor specified by the FACTOR = a number string. A factor greater than one increases the probability that a specified blip will be identified as the specified ship; a factor less than one decreases this probability.

The RESOLVE command can operate on whole class and type categories as well as on individual ships. Used in this way the command changes the probability of correct identification by class or type, but does not change an attacker's ability to discriminate among the ships within the specified class or type.

If the optional SHIP = { } is omitted, the program assumes that the contents of the entry enclosed by these braces is the same as that enclosed by this BLIP = { } braces.

The program requires that the blip and ship groups be of the same general category. A command such as RESOLVE, BLIP = TYPE/cv, SHIP = KITTY HAWK would not be accepted.

The RESOLVE command is cumulative. For example, if a user specifies a factor of five for KITTY HAWK with a first RESOLVE command and a factor of two with a second RESOLVE command, the effect is the same as that of a single RESOLVE command with a factor of 10.

The RESOLVE, RESET command removes all previously specified ship identity information available to the attacker from sources other than emitted radar signatures and order of battle data.

RESOLVE, DISPLAY lists the cumulative effects of user-specified a priori ship identification information so far entered.

A.7.0 <u>TRADE-OFF ANALYSIS</u>

A.7.1 SAVE AND DISPLAY A SURVEILLANCE AND INFORMATION SCORE

The SAVE, SCORE command computes and saves the surveillance and EW information scores for the current EMCON plan and specified strike name.

SAVE, SCORE, strike name

This command requires that the current EMCON plan be named. The aid will ask the user to name a current plan as yet unnamed.

The storage area can hold the scores for ten strike and EMCON plan combinations. At the user's option, data previously stored may be erased or a particular slot may be overwritten with new scores. Type HELP to obtain a list of the available options.

AD-A060 072 DECISION-SCIENCE APPLICATIONS INC ARLINGTON VA F/G 5/2

AN EMISSIONS CONTROL DECISION AID. VOLUME I.(U)

JUL 78 D F NOBLE, G E PUGH, J E DENSMORE N00014-77-C-0322

UNCLASSIFIED DSA-66-VOL-1 NL

2 OF 2

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END

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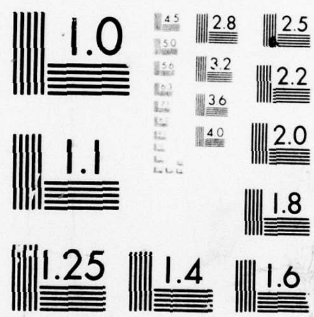

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

One may list scores previously saved with the SAVE, SCORE command with the command

$$\text{LIST, DETAILS, SCORE} = \begin{Bmatrix} \text{N} \\ \text{ALL} \end{Bmatrix}$$

"ALL" lists all scores thus saved. N is a number indicating the order in which a score was stored, or "slot," and is used to list only that score.

A.7.2 GRAPH THE SAVED SCORES

Used with the SAVE, SCORE command, the DISPLAY, COMBINED command generates a display graphically relating the values of particular EMCON plans relative to a given strike or of particular strikes relative to a particular EMCON plan. The display plots for each plan or strike the weighted average of the pure surveillance score and the pure EW score as a function of this weight.

$$\text{DISPLAY, COMBINED,} \begin{Bmatrix} \text{STRIKE} \\ \text{EMCON} \end{Bmatrix} = \text{one name}$$

A.7.3 COMPUTE RADAR EFFECTIVENESS AGAINST A SPECIFIC ATTACK IN WHICH THE ATTACKER MUST PLAN HIS ATTACK BASED ON IMPERFECT INFORMATION

When an enemy strike depends both on information given away and on surveillance coverage, then the effectiveness of a given standard strike against the task force can be used to assess the trade-off between information given away and surveillance effectiveness.

The commands used to calculate and display the results of such a strike are the SVSCOR and OUTCOME commands described in Sec. 4.2.

To be useful for a trade-off analysis, a strike must allocate attackers optimally to ships given only the information actually available to the attacker. That is, the strike must be one in which the LAYDOWN option as described in Sec. 2.4 is OPBLIP.

A.8.0 MISCELLANEOUS COMMANDS

A.8.1 REENTERING A PREVIOUS COMMAND

The user may repeat or edit the list commands processed by using the REPEAT option. Any one set of consecutive command strings may be edited or appended. The entire command may be repeated by typing: REPEAT, ALL. The general command is:

REPEAT, N, string A, string B, . . .

where N refers to the number of the command string at which one desires to begin editing.

The following examples illustrate how the REPEAT command may be used. Let us represent command strings by letters: ^*A, B, C, D, and suppose the above is a command that has an error in string C. It may be corrected to E by typing: ^* REPEAT, 3, E. Similarly: *A ,B may be converted to the new command, *A, C, D, by typing *REPEAT, 2, C, D.

A.8.2 CHANGING MODEL DEFAULTS

The user may change some of the constants or parameters used by the aid. These parameters are not associated with any particular threat or EMCON plan, but with the way the model processes information it is advised that care be taken when utilizing this default option.

The full name of the parameter key word must be known and typed in as the second string. Those which are made available for change are documented where they are of logical concern.

DEFAULT, parameter key word, new value

The following is a list of default parameters and the command where their use is explained.

DEFAULT	VARIABLE	REFERENCE COMMAND
J10ALO,	J10BRG	STRIKE
Y10GAM,	Y10BLO	STRIKE
Y10BHI,	J10NBR	STRIKE
Y06ALT,	Y06RCS	THREAT
Y06VEL,	Y06YLO	THREAT
Y06CEP,	Y06RW	THREAT
J06NWP		THREAT
MXHARMONIC		DISPLAY, FREQUENCY
EQSZIJ,	PIJMIN	LIST, GIVEAWAY
GSIDE,	GYPE, GCLASS, GID	LIST, GIVEAWAY

Example: DEFAULT, MXHARMONIC, 1 would change the frequency display maximum harmonic level to 1 (i.e., primary frequencies only.)

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